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ARCHITECTURAL DESIGN
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ARCHITECTURAL DESIGN IN CONCRETE

BY

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THE PHOTOGRAPHS COMPILED BY
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OXFORD UNIVERSITY PRESS
AMERICAN BRANCH . . . NEW YORK

1927

PRINTED AND MADE IN GREAT BRITAIN

WILLIAM BRENDON AND SON, LIMITED, PRINTERS, PLYMOUTH

ARCHITECTURAL DESIGN IN CONCRETE

For various reasons contemporary architects have been forced to regard concrete as a building material of increasing importance and to give it a place of prominence in design which was unknown in the nineteenth century ; in fact, so foreign has been the use of concrete to English construction that superficially many are inclined to regard it as a new material. It is, of course, common knowledge that this is not the case, and that in many forms concrete has been developed in previous periods so that it has been of great importance in the erection of famous buildings.

In all early buildings lack of mathematical knowledge and of the exact strength of Early Historical materials has tended to produce close spacing of heavy columns, Construction. large beams and spans giving the maximum amount of margin to the strength of material, necessarily involving a considerable amount of encumbrance on plan and very high cost.

An examination of the plan of an Egyptian building such as the temple at Karnak Egyptian reveals an extraordinary area of construction, and this massivity is Planning. repeated in elevation and perspective. The Egyptian apparently accepted absence of light and restricted planning as necessities, and as to a large extent they suited the mystery of Egyptian religion, the incentive towards improved lighting and freer planning was small.

Colossal expenditure of labour and material under any other social conditions would alone have caused a revolution in method ; but in Egypt the limitless amount of unpaid labour which was available prevented high cost from being a serious factor.

Even bearing in mind these factors, it is strange that knowledge came so slowly and that anything that could properly be called progress in construction was absent throughout the whole period of Egyptian work. This does not affect the undoubted impressiveness of Egyptian architecture acquired as a result of its massive and almost superhuman quality.

In Greek architecture a very serious attempt was made to use masonry in a more Greek Masonry. logical manner, and the figures published by Guadet have shown very clearly that the majority of Greek temples have been designed so that the maximum span of the stone lintol has been the basis of the proportion adopted for the colonnade, and that possibly the plans of the Parthenon, and other temples, were laid down so that they could be roofed by means of marble slabs. Columns were therefore spaced not at the dictates of personal taste or the idiosyncrasies of design, but according to the needs of construction. Early stone columns were exceedingly massive, but as the style progressed proportions were rapidly refined and the area of the columns assumed dimensions which were in some measure related to the work which they were called upon to perform. That

ARCHITECTURAL DESIGN IN CONCRETE

the Greek architect had some knowledge of the strength of his material would also seem to be indicated by the use of Ionic and Corinthian proportions which have been accepted by many modern designers as suited to the actual carrying of loads.

Roman Construction. In Roman architecture the need for providing large and unobstructed spaces led to the exercise of considerable ability.

Piers and columns were combined with arches and beams in such a way that an ever-increasing area was free from supports, and concrete was brought into use as a means of solving the problem of the clear plan. The Pantheon is one of the best known examples of a clear space, well lighted and completely unobstructed.

It is true that it represents the simplest form of dome construction, showing a hemisphere surmounting a circular building, and its lighting, by a central unglazed eye, also represents the simplest way of piercing a dome. But the fact remains that by means of a successful use of the wall and the dome, and by the employment of an exceptionally able combination of tile and concrete, a circular covered floor space was created with an internal diameter of approximately 150 feet.

Byzantine Vaults. Byzantine architecture solved many similar problems, but aimed at reducing labour and cost as well as at lightening construction. Thus in place of the solid static masses of the Pantheon it employed the dome and semi-dome in juxtaposition, it resisted thrust with counter-thrust instead of by inert mass. It reduced the thickness of the outer skin of its domes and pierced its walls, arriving at the wonderful plans of S. Sophia and S. Mark.

The Middle Ages. In the Middle Ages Gothic architecture progressed from the monastic churches of Norman times, with their massive columns, heavy arches, and small windows, all typical of primitive construction, until it reached the slender shafts, great spans, vast areas, and magnificent windows of the perpendicular period. All these types of construction, however, were applied to particular classes of building, and moreover were used where, for one reason or another, cost was a matter of secondary consideration.

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It is interesting to investigate the constructional methods of such periods and **Roman Concrete Building.** more particularly to examine in detail the buildings in which concrete has proved itself to be a material of great possibilities. Instinctively the mind turns to Roman architecture, where concrete formed the basis of many of the most impressive buildings which were erected about the first century of our era, and in some ways this system of construction is an exceedingly valuable study as a basis for modern work.

ARCHITECTURAL DESIGN IN CONCRETE

Sociologically it permitted a small number of highly skilled craftsmen to set out the building, to build the angles, groins and other features which formed the basis of the structure, and then allow slaves and labourers, who were untrained and often unintelligent, to fill in mass concrete between these angles and corners to form a substantial whole.

In Roman civilisation slave labour was an important factor, and therefore a system of construction which permitted the employment of an unlimited number of slaves was in itself an attraction.

The Roman engineer or architect would seem to have developed his system in such a way that by using great thicknesses for walls and domes he was independent of the bad mixing of concrete, bad filling, inefficient supervision, or even actual malice. Thus occasional bad workmanship entailed no serious danger to his structure. Possibly it was for this reason that his piers were of vast area, his domes of massive construction, his haunches heavily loaded, his thrusts taken by weight rather than by counter-thrust. Thus design and construction and the conditions under which buildings were erected were closely inter-related; under essentially practical conditions buildings were produced of magnificent architectural effect.

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In some ways the social system which made concrete construction so suitable to Roman life finds a parallel to-day and may possibly become even more in accordance with the conditions of work of the next generation, since the tendency of all industries appears to be in the direction of the employment of a small number of highly skilled men and a large number of operatives who are unskilled or only slightly skilled. On the other hand, several important factors of present-day building were non-existent in Roman times, and these must be appreciated if a proper comparison is to be drawn between classic architecture and contemporary work. These modern factors may be summarised as follows :—

**The Difference
between Roman
and Modern
Works.**

- (1) Economy of cost.
- (2) Reduction of period of erection.
- (3) Maximum amount of daylight in all rooms.
- (4) Reduction of number and extent of obstructions on plan.
- (5) Relatively low floor heights.

If the foregoing points are considered in conjunction with the proportion of unskilled labour employed, it will be realised that the parallel between Roman and modern concrete work differs on fundamental points, and this difference must affect the design of modern structures. Before proceeding with this investigation it is

ARCHITECTURAL DESIGN IN CONCRETE

well to see how Roman and Byzantine designers dealt with the finish of the buildings which they erected, and in which concrete construction was employed.

These early builders had no hesitation in using one material as a constructional element and covering it with another and purely decorative element which was employed as a facing. The cheapest and commonest decorative element of this kind was stucco, and it was of course employed extensively in all classes of work. The stucco was coloured in plain washes in unimportant places, and in interiors and possibly exteriors gave rise to the system of painted decoration which is called "Pompeian." It is not too extravagant to imagine that the development of concrete building may see substantial development of the art of conventional painted decoration externally and internally. In addition to painted stucco the Romans employed marble sheeting and marble mosaic and produced the magnificent interiors with which all are familiar. It is of the greatest value to note that the Roman and Byzantine systems, which accepted the principle annunciated above, are in many ways finding their counterpart in architecture to-day, where the builder and decorator seem to be steadily drifting apart although both are still controlled and employed by the architect.

By making the wall independent of the finished covering it is possible to employ one man or set of men to erect the carcase and another man or set of men to put on the decorative covering, and it may be that factors over which the designer has no control will dictate the procedure which this system indicates.

One other point in connection with Roman building in concrete is important, and that is the fact that the massive concrete domes which were erected were devoid of thrust as soon as the concrete was set.

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Passing from ancient to contemporary work, it is first necessary to visualise the elements of modern concrete construction. These may consist of (a) pre-cast concrete blocks, (b) mass concrete. Each of these main divisions, however, has a number of subdivisions, which appreciably alter the character of the finished work. Thus concrete blocks may be made of semi-dry material pressed into a mould, producing a more or less satisfactory surface, but incidentally having a measure of porosity which brings them below the standard of building which is expected in large and important structures. This type of concrete block, for purposes of economy, is usually made in such a way that the units are directly proportioned to the thickness of the walls, and its use has so far been largely confined to the erection of cottages. It has yet to be proved that these blocks wear satisfactorily over long periods.

ARCHITECTURAL DESIGN IN CONCRETE

Pre-cast blocks of other characters, however, are becoming increasingly important as building units and are usually described as "artificial stone." It is perhaps unfortunate that it should have been thought necessary for commercial purposes to use this term, since it tends to suggest that the basis of the design of such a building should be that of a stone structure, and that no appreciable alteration in conception is required to produce a thoroughly satisfactory building. Even the so-called artificial stone block, however, is manufactured in two distinct categories:—

- (a) With a rough concrete backing and a fine concrete face.
- (b) With the same density of concrete throughout.

Concrete blocks of this description have important points of construction which are capable of considerable use in designing; thus mouldings can be produced with practically no increase in cost over that of plain work, suggesting that considerable richness may be a characteristic of the material, while in the hands of a skilful sculptor the concrete can be carved before it is set, so that the finest and richest modelling may be introduced into it with one-tenth of the effort which is necessary to produce the same effect in stone. One or two modern artists in England have indicated the extreme value of work of this kind, notable amongst them being: Mr. Gilbert Bayes, Mrs. Phœbe Stabler, and Mr. Doyle Jones. A treatment yet in its infancy may prove to have a far-reaching influence on the production of concrete buildings.

There is, however, considerable interest in dealing with *in situ* concrete buildings, where external form is produced as a direct result of the constructional system, and where the finished appearance of the building is attained by the use of suitable moulds *in situ*. Up to the present there have been relatively few cases where the building has been left exactly as it came from the false work, and it may be that it is impossible to design false work which will give a thoroughly satisfactory finished surface. An increasing use is, however, being made of the original false work to form the design and details of the building so that when the wood boxes are struck the architectural treatment is complete except for a skimming coat of plaster.

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Proceeding from the consideration of ancient concrete building and the discussion of the elements of modern concrete buildings, it is necessary to visualise accurately the exact importance of the principles of design in modern work, since these must form the basis of the work of every modern architect. (a) In contemporary opinion it is an axiom of architecture that the

ARCHITECTURAL DESIGN IN CONCRETE

purpose of the building must be evident from an examination of its exterior. No longer will public taste accept as it did in the days of the great revivals one type of design for a church, museum, or railway station, or regard an aspect normally associated with a cathedral as a correct interpretation of the requirements of an insurance office. It follows, therefore, that if this expression of purpose is to find its place in the exterior of a modern building, the design of that building must arise directly from considerations of plan, of lighting, of situation, and of construction. (b) The provision of material requirements is of ever-increasing importance—a modern building must exactly comply with its programme since contemporary ideas of financial and practical considerations have relegated, possibly for all time, submission to inconvenience, merely because the architect wishes to produce some preconceived effect.

It is expected that the modern building will provide exactly for the needs of its occupants, and that any decoration, ornamentation, or architectural effect must be obtained without interfering with the satisfactory use of the building; it must be obtained in a straightforward and economical manner. This is not to say that the final design will necessarily be austere or that it may not have features of the greatest possible richness and interest, but it is indicated that such effects must be obtained

Originality. in a logical and direct manner. (c) A modern building, moreover, must of necessity be original, since originality is proclaimed as an expression of individuality, and individuality in all arts is a contemporary characteristic. It is of the greatest possible importance, therefore, to realise that if this requirement of design is fulfilled any system of copyism is entirely eliminated.

Modern design tending, therefore, to disdain the use of historical forms, it is possible that a virile style will arise, as the result of efforts upon the part of architects, to obtain original and effective buildings from the use of constructional forms, handled with originality and decorative effect. Plainness of purpose and economy of means will be important features in these original designs, and beyond any question the use of concrete lends itself to originality of treatment, because the absence of the precedent of similar work in the architecture of the ages forces the designer to think in a fresh vein.

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Modern construction is characterised by a number of important features which will form the basis of any logical system of design which it inspires.

The first and most important of these is the use of wide spans and slender supports, which, taken together, lay out proportions hitherto foreign to building. Proportion

ARCHITECTURAL DESIGN IN CONCRETE

dictates design and sets the key to which all detail must be worked. It provides the salient characteristics of the composition of which it is part.

Thus proportion, coupled with the continuity of main supports throughout the height of the building, is the visible effect of a fundamental change in constructional methods, for all systems of building prior to the advent of steel and reinforced concrete obtained height by raising one story, providing a covering platform or beam, and then raising another story. It was a necessary part of nearly all previous constructional systems that the continuity of the vertical support should be broken at each floor level, and in the early days of steel construction this same break of continuity was maintained. In a very short time, however, architects and engineers discovered that far better results were secured if the column or stanchion rose in a continuous line from basement to roof.

Architects in England imbued with the tradition of the Renaissance endeavoured to reflect this continuity of story in their designs by employing the colossal order of Palladio, ignoring the fact that by so doing they created width as well as height, thereby seriously obstructing the area of façade available for lighting and intensifying the difficulties of construction by rendering necessary a very great thickness of wall or the introduction of some type of thick support or double stanchion in the lower stories. A design which follows the evolution of concrete construction and combines the wide span, the slender support, and the continuous vertical member immediately begins to achieve a peculiar distinction, which by virtue of the fact that it has arisen from the constructive method employed and that this constructive method is different from that of any other epoch becomes at once "modern" in the best sense of the word. Incidentally a number of extremely valuable facts are open for investigation, and above them all is the dominating idea of verticality as distinct from the old horizontality of the classic tradition. In some ways the spirit of Gothic architecture pervades this phase of building, yet the standard of craftsmanship, scarcity of labour, and ecclesiastical spirit, which were the dominating features of Gothic building, have ceased to exist, and the apparent similarity of form has no connection in fundamental fact. Although, therefore, to the casual observer there appears to be a distinct connection between the architectural motifs of the Middle Ages and the general characteristics of a few modern concrete buildings, closer investigation reveals differences which are of a far-reaching character.

A number of architects in different parts of the world have attempted to handle designs which logically develop the constructional features of a concrete building, and a survey of the results of their efforts, with this particular point in mind, will probably crystallise the trend of contemporary thought better than any amount of description.

ARCHITECTURAL DESIGN IN CONCRETE

Verticality carried to its utmost limit has been the keynote in the design of the Hollywood terminal building at Los Angeles, California, by Morgan Walls & Clements (Plate XL). In studying this building it should be noted that, although it possesses a Gothic atmosphere, this suggestion of mediævalism has appeared, not as a result of an attempt to impose a Gothic design upon a structure having no Gothic elements, but as a result of accepting the constructional principle of the building and forcing it to become the basis of the design. This building demonstrates the fact that it is a motif of modern as well as of mediæval construction to carry a vertical support from basement to roof. It is a feature of concrete construction no less than

Subdivision. of mediæval masonry to emphasise a wide bay and to fill it with a subsidiary pier. Thus the main constructive element is repeated as a number of bays on the façade, and a suitable lighting element is obtained by dividing these bays with subsidiary vertical features.

Architecture and Construction. It might be contended that up to this point an engineer, devoid of architectural training, could have produced an equally satisfactory building ; but architecture consists of an ability to handle constructional elements so that they create a beautiful whole, and in this case the architects have succeeded in displaying the constructive elements of the building in such a way that the result is exceedingly impressive.

It is fascinating and instructive to visualise the interplay of structure and design in this building. Its lighting units are well distributed : its columns are no larger than calculation shows to be necessary : its decoration has not absorbed valuable land area or trespassed upon the demands of practical use ; yet it is architecture and not engineering, it has personality and distinction, and looks as if it might have been produced as a pure conception of architecture instead of being evolved as a practical proposition. It was in this manner that the mediæval church builders handled their designs and the Greek artists their temples.

A similar vertical motive has been employed in the building for the American News Co., New York (Arch. Russell T. Cory, Plate XXXIX), where the constructive unit is emphasised and the lighting unit is suitable for the type of building and the kind of rooms which combine to form its whole. Probably the architectural value of the American News Co.'s building (Plate XXXIX) is less than that of the Terminal building, but limits of cost and other unavoidable considerations may have forced these conditions upon the designer.

That the continuity of the vertical support is not a mere caprice of one designer or of one type of design is shown by the frequency with which it is appearing in modern work in all parts of the world, and special attention should be given to the way in which it has been handled architecturally in the exteriors of the factory at Stockholm by Ture Sellman (Plate LIV), the Shredded Wheat factory at

ARCHITECTURAL DESIGN IN CONCRETE

Welwyn by Louis de Soissons & A. W. Kenyon (Plate LVII), (18) Munich, Bavaria, Water Tower, Bavarian Motor Works, by Professor Otto Orlando Kurz (Plate LX), while interiors display the same constructional element as shown by (10) Staircase detail (Plate XXXIV), (11) Hamburg, "Gewerbehaus" Main Staircase (Plate XXXII), and (12) Hamburg, School of Arts and Crafts, Staircase, by Fritz Schumacher (Plate LXXXVI).

Shapes and features once created have a fascination of their own, and the high narrow opening reappears in the Radio Tower at Kootwyk, Holland, by J. M. Luthman (Plate LXIV), and (18) Munich, Bavaria, Water Tower (Plate LX), although possibly these are mere piercings of flat walls and are not necessarily demanded by the architectural development of constructional features.

An extraordinarily fascinating variation of this theme appears in the Church at The Work of Le Raincy, in Paris, by Messrs. A. & G. Perret (Plates XXIV, A. & G. Perret. XXV, XXVI, XXVII). This church, by its strangeness of form, breaks away from ecclesiastical tradition, and to that extent may offend the religious views of some; but from the point of view of design its enrichment has been developed by the use of concrete forms employed to produce on the exterior an intensely vertical treatment with large lighting spaces, and in the interior to accept the practical requirements of a church by using the slender supports made possible by the use of reinforced concrete and to fill the spaces between the principal structural members with a lace-like tracery of straight lines, arising from a logical and reasonable use of concrete forms. The scale of the church is elusive. The multiplicity of its members, the very narrow proportions of its tower, give it a strange appeal which leaves the spectator divided between admiration of its skill and originality and anger for its disdainful abandonment of all recognised forms. It lacks repose, yet it is an extraordinarily fascinating structure.

A second attempt to produce a similar design by the same architects is shown in the church at St. Denis (Plates XXVIII, XXIX). The exterior of the nave of this church is in some ways more satisfying than that at Le Raincy, as its square forms are more restful and the semi-solidity of occasional piers gives a feeling of greater stability to the whole. The outline of the tower loses in virility and is in some ways a poor climax to the intensely original treatment of the whole.

Verticality still possessing an unmistakable classic appearance is not entirely impossible and is seen at its best in (5), Finsing, Bavaria, Water Modern Classic Work. Power Station, by Professor Otto Orlando Kurz (Plate LII), and (6) Leipzig, Fair Exhibition Hall, by Baurat Pusch (Plate VII), and in the design of the factory at Stockholm, by Ture Sellman (Plate LIV).

Referring back to (6) Leipzig, Fair Exhibition Hall, by Baurat Pusch (Plate VII), the distinction between the classic colonnade, which was obviously the

ARCHITECTURAL DESIGN IN CONCRETE

underlying motive, and the way in which the concrete structure has been handled, is a very valuable example of the possibility of adapting an accepted architectural feature to a new material and making it effective.

The continuous vertical element which has just been cited as an outstanding feature of concrete and steel construction has, however, a counter-part which at first sight seems to be a distinct contradiction of terms; this second salient feature is the wide span. Previous periods of great building have rarely known the wide opening of shallow height which is so common a feature of industrial design. It is the result of the combination of the low floor to floor height of the many-storied structure with a demand for maximum lighting area of the power of steel to cover wide spaces without the need for substantial depth. These wide shallow openings like continuous vertical members appear again and again in modern design, and since the proportion of the openings differs so greatly from those with which the eye is familiar, many designers find it difficult to think in the terms which construction dictates, and to entirely dissociate from their minds the whole tradition of the high narrow opening, a difficulty, moreover, which is emphasised by the fact that the spectator is familiar with the narrow opening and is suddenly presented with something which necessitates a readjustment of view, by no means easy.

The Garage in Paris, by Messrs. A. & G. Perret (Plate LV), is a good example of the wide proportion in openings where maximum daylight has been combined with minimum construction. This design also shows a skilful combination of the wide opening with the continuous vertical support, although the façade loses cohesion by the introduction of powerful circular fenestration in the centre window. The difficulty of combining the continuous vertical column and the wide opening in a satisfactory manner is indicated by a study of the Shredded Wheat Factory at Welwyn Garden City (Plate LVII); an element of uncertainty of intention seems to prevent complete acceptance of the architectural scheme. The wide opening appears again in the illustration of the Auto Club at Los Angeles, California, by Hunt and Burns (Plate XLV), the High School at Healdsburg, California, by W. H. Weeks (Plate LXXXV), which has beautifully proportioned subdivision, and in examples from different classes of building shown by (19) Cassel, Germany, Factory, Carpenter's Shop, by Curt Von Brocke (Plate XLIX); (15) and (16) Paris, Private Houses, by Le Corbusier (Plate LXIX); (1) Paris, House, by Andre Lurcat; and (2) Paris, House and Studio, by A. & G. Perret (Plate LXXI).

The next quality of concrete which must receive attention is its monolithic character. This feature is new to the designer who has hitherto dealt with all large surfaces as composed of a number of small units, and has used the divisions of these units as a means of giving scale and interest

ARCHITECTURAL DESIGN IN CONCRETE

to his design. A monolith is impressive if its size and unity can be appreciated, and if the ability to express these qualities can be acquired a new group of compositions should be realised. If monolithic unity is considered alone, the most successful design illustrated here is undoubtedly that of the Einstein Tower by Eric Mendelsohn (Plate LXII). In this design the rounded corners, the splays, the broadly recessed reveals, the battered faces and absence of mouldings make the tower and the rooms at its base look as if they were created by the sweep of a giant hand. It is even difficult to imagine the building growing course by course or by the aid of scaffolding. It is true that the unique nature of the subject lends itself to an original handling, but this does not detract from the brilliance of the brain which could conceive so unified a composition.

A monolithic character may, however, be imparted to a concrete building without necessarily employing unusual shapes or a treatment which achieves such superlative originality. Absence of conventional mouldings and, above all, the absence of a crowning cornice do much to create this feeling of a unified mass, and the quality of the monolith then becomes one of many valuable attributes of a sound design. Several of the buildings here illustrated can claim a part of the distinction achieved by this means, and in this connection mention may be made of the Auto Club, by Hunt and Burns (Plate XLV) and Elks' Temple, Los Angeles, California, by Curlett and Beekman (Plate XLII).

A further study of (7) Cologne, Germany, Restaurant, built over Tower of Old Fort, by Wilhelm Rephahn (Plate VI), will show that the Light House structure is essentially suitable for its purpose, achieving real economy of ground space and monolithic design by the use of a type of construction possible only in concrete. No brick or masonry building would have appeared as this building appears, yet it is not an eccentric design, neither does its individuality descend to any form of eccentricity.

In design (8) Cassel, Germany, Coal Bunker and Boiler House, by Curt Von Brocke (Plate XLVII), this monolithic atmosphere is present. It is a building which has probably come into existence as the result of purely practical requirements of a simple engineering character, yet there is a sense of architectural fitness which, carried slightly further, would have made it a building of very real architectural distinction.

The East Surrey Water Works at Purley, designed by A. G. Wallis, Gilbert and Partners (Plate LVI), has also attained a solidity of effect, coupled with a modernity of treatment, which is extremely suitable to the material in which it is erected.

Its vast windows and simple subdivisions naturally arise from the conditions of the problem and from the materials employed; they are logical and sound, they

ARCHITECTURAL DESIGN IN CONCRETE

have interest and intellectual appeal, and therefore fulfil many of the qualities which appear to be indispensable to good design.

Concrete has been successfully used for the construction of buildings which have been designed on traditional lines, and in some cases adjustments have been made in line or detail which appear to be peculiarly fitted to the material.

Outstanding examples of this type of work are the High Schools at Piedmont (Plates LXXIX, LXXX) and Mountain View, California (Plate LXXXIII), both by W. H. Weeks. These buildings have an unmistakable Italian atmosphere, yet the contrast of rough surface and flat wall which has been used with an exceedingly skilful placing of ornament have produced buildings which have a great deal of architectural attraction, as well as appearing to be very suitable for use in a concrete structure. Ornament of a repeating character again reflects the material, inasmuch as it allows a mould to be made for one small section and for a large amount of ornament to be cast from the same mould. The low relief of the ornament gives it a feeling of texture of which more will be said later.

W. H. Weeks has used Italian models in a large number of his buildings, but in each instance manages to give them an atmosphere of personality which raises them above the realm of mere copyism.

Finally, the Radio Tower at Kootwyk, Holland, by J. M. Luthman (Plate LXIV), has a very impressive silhouette which very nearly achieves the monolithic excellence of the Eric Mendelsohn building.

Whether or not architects, as a whole or contemporary taste, are satisfied with this emphasis upon the monolithic qualities of the material, is for the present of no moment. It is sufficient that the buildings appear to have been produced from concrete moulded *in situ*, constructed as one mass and therefore possessing logical unity to a very marked degree. Some of these buildings have a very special purpose, which may have contributed to their peculiar character, but nevertheless only men possessing marked individuality would have been able to visualise the use of a new material so completely and to have carried out the detail with such singleness of purpose.

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Passing from exterior to interior design, it is well again to recall that the history of building is the history of progress from timid to courageous construction.

The effect of the evolution of construction from the closely spaced massive masonry columns of Egypt to the high thin continuous support visible on the exterior of contemporary concrete buildings, together with the wide low bay or opening, has

ARCHITECTURAL DESIGN IN CONCRETE

already received attention. The effect of this adjustment of proportion and detail upon interior design is at least as far-reaching and in some ways more fundamental than the effect of the new proportions upon exterior designs.

This alteration of the shape of features commences with the replacement of the solid masonry column, with its masonry proportions, by the reinforced concrete column, with its steel proportions. Inasmuch as the architect and the layman are imbued with traditional forms, every spectator finds it difficult to reconcile ideas of safety brought about by viewing masonry construction with a feeling of safety in looking upon the much more slender forms of steel and concrete construction.

The lay mind for this reason, if for no other, is apt to dislike concrete and steel forms without being able to define the reason for this dislike. The contrast in form of the two systems is very forcibly demonstrated by comparing the interior of the Church of St. John, Los Angeles, California, by Pierpont & Walter Davis (Plate XX) with the interior of the church at Le Raincy, Paris, by A. & G. Perret (Plates XXV, XXVI, XXVII). The former church follows closely and unmistakably the traditional forms of masonry construction, and only suggests concrete construction to the extent to which artistic courage has allowed the architect to house the worshipper in broad, flat unornamented spaces which seem to be peculiarly suitable to the use of concrete walling. The interior of A. & G. Perret's church in Paris is supported by ferro-concrete shafts which have not attempted to reflect the proportions of tradition columns. These shafts may be open to criticism. They seem to strike the vaulted roof like poles, almost suggesting that they will pierce the structure. It may be that, with added experience in the designing of work of this character, a much more satisfactory method of treating the junction between the ceiling and the column will be automatically evolved while still retaining the advantage of the small diameter and the modern desire for simplicity of detail.

It seems, however, logical to endeavour to eliminate completely the column which is such an obvious disadvantage to a church, and to cover it, or any similar building, with some other system of support. Before the problem is satisfactorily solved no doubt many experiments will be tried.

The church at Vincennes, by J. Marast (Plates XXX, XXXI), is one of such experiments where a building of considerable area is roofed in a very impressive manner by means of a series of ribs which divide the roof into panels and enable it to be carried over the whole area of the plan without the need for any intermediate support. This system of construction automatically dictates an entirely fresh scheme of

Columnless
Interiors.

Concrete
Vaulting.

ARCHITECTURAL DESIGN IN CONCRETE

decoration, and in the case of the arched design for the Vincennes church the constructional element has necessarily become the basis for the design of the building. Incidentally, attention must be clearly focussed upon the fact that it is impossible to design such a building without a very clear knowledge of possible constructional forms. The details for the reinforced or mass concrete members of a building of this character will be so complicated and difficult that the employment of an expert who will be responsible for the calculations will be a necessity, but it must be evident that it is the architect who will decide upon the form of the structure, settle its architectural character and its system of ornamentation.

The use of the slender shaft or column is not alone confined to church design. It has immense value in many other types of buildings, as, for instance, in Illustration 9, where a roof is required over a large area which can be supported at many places, but where the supports must cause as small an obstruction in plan as possible and must also leave a clear view of the great buildings beyond. In this case the column has been provided with a small square cap and crowned by a flat ceiling, devoid of heavy beams, producing a simple, economical, and effective system of construction and involving a fresh conception for the architectural treatment of the whole. A scheme similar in principle has been employed in a number of factory buildings, and has acquired the name of "Mushroom" construction.

"Mushroom" Construction. An illustration is given of the Shredded Wheat Factory at Welwyn Garden City, designed by Louis de Soissons & A. W. Kenyon (Plate LVIII).

The principal advantage secured in this case is the elimination of deep beam projections which would obstruct the light. The column is still somewhat massive as a result of the loads to be carried, and there is no doubt room for the invention of steel and cement of even greater carrying capacity, which will allow the dimension of future columns to be reduced. The continuous vertical support referred to in Internal Vertical dealing with external design reappears in certain internal treatments and similarly has a very appreciable effect, not only upon the detail, but upon the type of treatment which is employed. This is apparent in the staircase details given in Illustrations (10) Hamburg, "Gewerbehaus," Staircase detail (Plate XXXIV); (11) Hamburg, "Gewerbehaus," Main Staircase (Plate XXXII); and (12) Hamburg, School of Arts and Crafts, Staircase, all three by Fritz Schumacher (Plate LXXXVI). In each of these cases the supporting member and not the balustrade is the dominating line, having the effect of enlarging the scale and focussing attention upon the stairs as a whole instead of allowing it to wander up and down a succession of parallel flights. Fig. (12) suffers from a lack of finish which prevents the design from being as attractive as its general motif deserves.

ARCHITECTURAL DESIGN IN CONCRETE

Industrial and commercial buildings, however, gain as much or more than churches by the elimination of all internal supports ; but whereas the church has usually a single story and represents an example of a problem previously partly or wholly solved in stone, the many-storied commercial building has features hitherto unknown. The possibilities of such a constructional system are shown in Illustration (13), Breslau, Germany, Centennial Hall, Interior, by Max Berg (Plate II), where a wonderful erection of domes and arches has allowed the architect to create a vast unobstructed space which is eminently suited to the demands of a great seated audience.

The cantilever construction of one of the galleries is more clearly shown in Illustration (14), Breslau, Germany, Centennial Hall, Gallery Supports, by Max Berg (Plate IV), where the great overhang of the gallery is supported by reinforced concrete shapes which have a vague resemblance to weird arms of architectural outline. The architect of this building has not been afraid to use the constructional forms as a part of his design, yet it is felt that he is working as a man experimenting with his material and who is not yet completely familiar with the way in which it should be ultimately handled. Too much of the skeleton is allowed to appear and to mar the proportions of the whole, and it lacks the beautiful forms of the flesh, which ought decently to clothe the bones. With the greatest desire for truthfulness of design, it is quite unnecessary to show every member of the constructional system. Sound judgment on this point will lead to a right conception of work which should be displayed and work which should be hidden.

That reinforced concrete can cover very large areas with many floors needing only the introduction of a small number of vertical supports is evident from a study of the factory building erected in Paris to the design of A. & G. Perret (Plate LIX). The supports in this instance appear to be reduced to an infinitesimal area. The whole structure is supported by a monolithic arch-rib, pressing against the floor beams and stanchions in such a way that each can be reduced to the smallest possible dimension, and thus give the maximum amount of light and air to the building as well as the greatest possible freedom of movement for plant and staff ; forming as a whole a purely practical building with an architectural atmosphere exceeding that of many factories built upon more commonplace lines.

The interior of the Civic Shrine at Los Angeles, California, by J. C. Austin (Plate XCI), shows a roof supported by a series of concrete arches covering a wide span where the structure itself is made into an extremely decorative element.

For some reason this building displays an effect of heaviness which has not been evident in the more airy buildings referred to in previous pages, but the combination of post, beam, and cantilever of arched rib and vertical clerestory is one which the architect has set out to handle as a result of the dictates of his system of construction

ARCHITECTURAL DESIGN IN CONCRETE

and has turned into an effective decorative treatment by means of a system of modelling and painting.

Concrete forms are the basis of the striking decoration of Grauman's Theatre at Los Angeles, by William Lee Woollett (Plates LXXXVII, LXXXVIII, LXXXIX, XC). Great originality is displayed in the handling of the detail of this work, and yet it does not seek to attain this end by ignoring structure and merely applying superficial ornament which is unrelated to the work beneath. It is easy to imagine such work finished in strong colour, and thereby obtaining enhanced effect.

§

The attraction of the old weather-beaten stone bridge has been felt by all, and only circumstances of irresistible force would cause the abandonment of stone as a constructional material for this purpose. These circumstances exist, however, firstly in connection with cost, and secondly in connection with large spans and heavy loads. The bridge at Welwyn Garden City, by Louis de Soissons & A. W. Kenyon (Plates XCV, XCVI), and the bridge near the Halmstad-Noissjö railway station, Sweden (Plate XCIX), both show concrete designs which depart little, if at all, from the principles of bridge designs in stone.

The great spans of the Ervalla Bridge, Sweden, by A. Björkman (Plate C), the bridge at Veland, Sweden (Plate XCIX), by the same engineer, and the bridge at Latah Creek, Spokane, Washington (Plate XCVIII), are, however, in a different category. The form of all these examples marks them unmistakably as structures in which steel plays an important part, and they possess elements of design which give them an attraction to the architect. The two Swedish bridges are both old steel spans which have been covered with concrete for maintenance purposes, yet they both have a beauty of line which tends to raise them above the level of mere utilitarian works. The Washington example is more graceful and perhaps more characteristic of concrete, as well as being of greater architectural importance.

The cantilever bridgeway, the position of the piers, and the handling of the subsidiary arches all suggest a knowledge of the requirements of bridge work and a familiarity of the architect with concrete, which not only brings success to the design, but also suggests to the layman that architectural appearance is by no means inconsistent with the production of practical and logical work.

The combination of the arched rib and reinforced support carrying a vertical track lays the foundation for a very interesting architectural composition, but it is impossible to produce a design of this character unless there is collaboration between architect and engineer, or the architect has sufficient detailed constructional

ARCHITECTURAL DESIGN IN CONCRETE

knowledge to be able to prepare a design which will have members of approximately correct dimensions, so that detailed calculations may be made by the engineer without the necessity for substantial alteration in design.

There are many indications that bridge designing is reverting to the architect, but it is evident that success necessitates a large amount of constructional knowledge, and that this knowledge will no longer be of the same empirical character as that required in the design of the old stone bridges, which have, in the past, been such picturesque and, in some cases, magnificent features of river scenery.

§

Contemporary taste tends to enhance the architectural value of buildings, which rely for their effect upon outline and subdivision rather than Proportion and Subdivision. upon the application of mouldings or ornament, and for this reason the simplest and the most important buildings often alike possess an austerity of appearance which is relieved from baldness by the introduction of new forms or some concentrated piece of ornament efficiently placed.

House design has reflected this attitude of mind, and in a few outstanding instances houses have been built which carry the ideal of simplicity to its utmost limits. Some of these simple façades are shown in Illustrations (15) and (16), Paris, France, Private Houses, by Le Corbusier (Plate LXIX), where the face of the building is composed of a single broad surface, relieved by window openings which are carefully collected into horizontal bands and placed in such a way that they form in themselves a definite enrichment to the building.

In the case of (16), Paris, France, Private House, by Le Corbusier (Plate LXIX), an overhanging bay produces a sharp square shadow which seems to furnish the façade to a remarkable extent, the entrance doors being similarly emphasised by the use of a simple square hood which gains an unusual amount of effect by being placed in an otherwise unbroken surface.

The simplicity of treatment of this exterior is again found in Illustration (1), where there is no attempt whatever at ornament, and where the architectural character of the building is obtained by "bowing" the front, and thereby producing a mass which seems to be particularly suitable for concrete construction and to impart an architectural character to the building.

Illustrations (3) and (4) are further examples of the same principle, the introduction in both cases of angle windows giving a touch of quaintness to the building and breaking down the extreme severity of the remaining portions of the composition.

It should be noted in all these instances that the thin steel sash has been employed,

ARCHITECTURAL DESIGN IN CONCRETE

and that it has a certain affinity of effect with the flat wall surfaces in which it is placed.

The amount of money available for these buildings is extremely small, and it is a very great material advantage to be able to produce an attractive design with the smallest possible outlay.

Squareness of outline constantly occurs in the concrete buildings which have recently been erected, and a very large number of illustrations in this book accept this as a characteristic of architectural expression in concrete.

The same quality of austerity reappears in the interiors illustrated in (17) and (18), Paris, France, House Staircase, by Le Corbusier (Plate LXX), which show the treatment of a cantilever staircase in concrete in which the balustrade is formed of a plain thin wall which is partly structural and partly the natural staircase enclosure. It should be noticed, in the case of (18), that these square structural forms lend themselves particularly well to the use of painted decoration and low relief modelling.

It is, however, important to realise that simplicity and severity are by no means the only possible architectural qualities of concrete, and that the extensive use of ornament properly handled may be equally characteristic. Ornament used to produce strong contrast is seen to good effect in the main entrance to the High School, Mount View, California, by W. H. Weeks (Plate LXXXIII), where the centre feature has been given a broad, flat uninterrupted surface and has been enriched by the use of two extremely effective columns, representing the maximum amount of richness which it is possible to introduce, and which are aptly connected to the structure by the introduction of a modelled panel and shield in the centre of the gable.

The principle of contrast is frequently employed in the architecture of California, which still retains a strong Spanish tradition, and special attention should be directed to the design of such buildings as the Hollywood Terminal at Los Angeles, by Morgan, Walls & Clements (Plates XL, XLI), the Fine Arts Buildings, and the Monument in Balboa Park, San Diego, both by William Temple Johnson and Robert W. Snyder (Plates XVII, XVIII). The architects of these buildings have not hesitated to use a considerable amount of ornament and have employed it in such a way that it becomes texture rather than decoration, much as the builders of perpendicular Gothic churches used surface carving on their masonry. The result which is obtained by the careful handling of relief contrasted with plain surface and severity of silhouette is often highly valuable and quite characteristic of certain classes of buildings. Ornament of this character has great possibilities. It can be cast and modelled, and is therefore suitable to concrete. It can be repeated without sense of monotony,

ARCHITECTURAL DESIGN IN CONCRETE

and if the modeller is able to give sufficient personal attention to the work, the design can be slightly varied as each piece comes from the mould and while it is still in a semi-plastic condition, while actual carving can be used by rapidly cutting the face of the material as soon as it is cast, and before it is set, finally finishing the enrichment with chisels and points, as would be the case in carving masonry.

In handling a doorway, such as that to the Hollywood Terminal Building (Plate XLI), it may even be possible to cast a block the base of which is black aggregate, and the surface white aggregate, and cut away the surface as in scraffito work, thus producing a strong contrast not only of form, but of colour. With proper skill in the use of this process many combinations of colour are possible, and some form of scraffito may therefore become one of the frequently adopted motifs for the future enrichment of concrete surfaces.

A further development in the handling of detail in concrete is shown in the churches at Le Raincy and St. Denis in Paris, both by Messrs. Repeating Ornament. A. & G. Perret (Plates XXIV, XXV, XXVI, XXVII, XXVIII, XXIX). The enrichment of the walls of these buildings has been produced from the same sets of moulds casting similar concrete members, the units being erected to different designs and producing buildings which have the same general atmosphere, but which are by no means replicas. The illustration shows that advantage has been taken of the unquestionable economy of repetition in cast work, yet the result has not been open to the condemnation of the production of what Mr. G. K. Chesterton describes as "a number of St. Paul's Pups." The particular kind of architectural skill which has been employed in piecing together units of this character may be, by some, derided; but there is a very real purpose to be served in meeting the rigid restrictions of cost, often placed upon builders by lack of funds, and providing the owners with a building which has many elements of originality where otherwise they would be forced to erect a commonplace structure of no architectural attraction whatever.

It is obvious that if the attraction of colour can be added to these buildings, if they can be given a texture of real interest, their artistic value will be enormously enhanced and they will be able to take their place as works of a high order of building.

§

Texture in concrete must be considered in conjunction with certain inherent difficulties of the material as it is at present used, which have tended to be ignored, since they are regarded as inevitable. These difficulties are : (a) colour, (b) crazing, (c) variation in colour in the form of water-lines, (d) variation in texture.

ARCHITECTURAL DESIGN IN CONCRETE

It is possible, however, that the design of a concrete structure is incomplete unless it takes account of these factors, and so adjusts detail and ornament, they are likely to become invisible to the beholder.

The first and most important is the fact that concrete, as normally made with Portland cement and the usual aggregates, is unpleasant in colour, and that a large mass of concrete tends to be unattractive for this reason alone. The second and next important fact is the crazing of the surface of concrete where fine cracks occur in the surface which are almost invisible but rapidly fill with dust, and in the majority of cases produces a mass of dark disfiguring line which cover the surface of the building or of the features which are executed in concrete and make the general effect exceptionally unpleasing.

It is to be noted that a large number of the buildings which are here illustrated have large areas of plain surface, and that, so far as the photographs
“Crazing.” are concerned, there is little or no evidence of “crazing.”

It should be remembered that “crazing” is most evident in highly finished surfaces and often does not occur at all in rough surfaces. This is usually explained by the fact that trowelling with iron tools brings the neat cement to the face of the work, and that the particles on the surface have, when set, a coefficient of expansion which differs from that of the coarse material which forms the backing.

“Crazing,” therefore, may be partly overcome by the way in which the surface is treated, and a thin coat of stucco or rough-cast will probably overcome the difficulty. Two other possibilities, however, present themselves : one is the artificial production of texture, and the other the use of a considerable amount of surface ornament. In pre-cast work “crazing” is generally reduced, but is still a serious anxiety to the makers.

Texture may be obtained in a number of ways. The first consists of the use of
Exposed special aggregates which are mixed with the surface of the concrete
Aggregates. and are left exposed when the work is finally set. It is simple to create this “aggregate” texture if the concrete is pre-cast, and the concrete blocks are produced in a factory. Coloured sands, broken stone, granite, or marble tend to overpower the unpleasant colour of the cement and often result in an exceptionally interesting surface. It is usually necessary to experiment with the aggregate and to obtain an attractive mixture which gives a good effect both for colour and size, but it is also important to ascertain that the aggregate used is of a clean character and does not affect the setting properties of the mixture. Many shades of red, pink, blue-grey, and green produce a material which has much of the beauty of natural stone and yet obtains an individuality of its own. The use of coloured marble chippings, broken to pass through a small sieve, gives a brilliancy to the work which is often absent from the stone aggregate.

ARCHITECTURAL DESIGN IN CONCRETE

Granites, if used as aggregates, possess natural mica which forms an appreciable part of the concrete and brightens the general effect of the work.

It is a drawback of some of the more expensive aggregates that they raise the cost of the concrete to the level of that of natural stone, and up to the present architects and the general public have tended to prefer the natural to the synthetic article. It is, however, by no means certain that stone will look better or weather better than a manufactured article made of first-class Portland cement and first-class aggregate, as the latter will be of exactly the same composition throughout, and therefore free from the defects which are found in all but the very finest samples of masonry.

The use of satisfactory aggregate, both as regards colour and texture, is not always sufficient to produce the kind of surface which the architect requires, as the cement in the concrete tends to find its way to the surface and to obscure the best qualities of the aggregate. For this reason a number of attempts have been made to scrub the face of the block with bristle or wire brushes before the work is properly set, thus exposing the aggregate itself and roughening the surface of the concrete, so that "crazing" is non-existent, and the concrete surface avoids the unpleasantly smooth effect which is apparent when iron trowels are used or when blocks are cast in iron moulds.

Scrubbing, however, is quite a skilled process. If it is carried out in a casting factory it is not so difficult, since men can be specially trained for the work and are subject to adequate supervision. As a result the moulds are struck at the right moment, according to the state of the weather, and the scrubbing can be carried as far as the architect desires.

The execution of any concrete work in a factory, however, is relatively expensive because of the cost of transport, and attempts have therefore been made to obtain a satisfactory texture by scrubbing concrete which has been built *in situ*.

It has, however, been almost impossible to strike the moulds at the identical moment which will leave the concrete safe from the dangers of settlement, of frosts, rain or heat, and at the same time leave them soft enough to be scrubbed equally over the whole face of the building. As an alternative, the face of the building

Acid Treatment. has been covered with acid, so that the acid will eat away small particles of cement, leaving the aggregate exposed evenly over the whole façade; the surface of the work being subsequently washed with a plentiful supply of clean water to remove all traces of acid.

There are, however, certain very dangerous possibilities which stand in the way of the use of this system, because if the building has a steel frame, or is constructed with reinforced concrete, any minute traces of acid left behind may be driven into the face of the work by the action of the weather and may seriously affect the steel work with disastrous results.

ARCHITECTURAL DESIGN IN CONCRETE

Blocks have been similarly treated with acid in the factory, and in the case of a building composed entirely of concrete blocks there are only those dangers in its use which leave it possible for the action of the acid to continue to eat away the cement and allow frost to attack the surface of the work.

Experiments with colour have proceeded in other directions, the first of which has been the employment of coloured sands to produce coloured concrete. A very attractive pink was used in a house erected near Northwood by Mr. D'Arcy Bradell, pink sand and Atlas white cement being the material employed.

Coloured sand or aggregate is undoubtedly the safest and most satisfactory means of producing colour in concrete.

A number of coloured mediums have, however, been placed on the market for the purpose of producing rapidly and cheaply a coloured concrete. Some of these materials have not produced very satisfactory results, and it is one of the difficulties of their use that it is often impossible to discover whether the building will look well until the coloured block has been erected for some little time and has been exposed to the action of the weather.

A number of experiments were recently made by Mr. R. R. Butler, M.Sc., A.I.C., F.I.C., upon the use of water-bound dyes for colouring concrete. If such a process could be perfected it would be easy to mix the colouring material with the water which is to be employed for the concrete, and colouring would be cheap, easy, and effective. The concrete would not have to be loaded with a substantial amount of inert colouring matter, and therefore would be a better material. So far the experiments have not proved to be successful, although one extremely good colour (a green) appears to be a possibility.

Apart from the treatment of surfaces with aggregates and colour is the possibility of using a surface coating as a rough-cast.

A number of these finishes must be familiar to all and differ in no way from the treatment employed in rough-casting houses built in brick or any other material.

§

Other methods of handling the surfaces of concrete buildings may be employed in the future, such as the use of stucco covered with painted ornament in the Pompeiian manner, or the employment of mosaic or marble sheeting, such as that used in the more important buildings in Roman and Byzantine work. There seems also much to be said for the revival of "scraffito," which is eminently suited to the employment of coloured concrete. Bands of strongly contrasting ornament could be introduced into the design and carry considerable interest into the plain surface of the walling.

ARCHITECTURAL DESIGN IN CONCRETE

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Designing acquires a high part of its fascination because it must of necessity reflect the spirit of the time in which it lives, and must become a real expression of contemporary thought as crystallised in the minds of the men and women of its period.

It is an extraordinary commentary upon European history to find that the culture of Rome has for so many years controlled the minds of men. It would be equally fascinating to reflect upon the effect of the ecclesiastical domination of European countries throughout the Middle Ages, when civilisation was the Church and the Church was civilisation. That these factors existed, and that architecture reflected the social conditions of each period, is undeniable. Thus design in concrete must reflect contemporary thought. True design must conform to climatic conditions, to working conditions, to the principles of hygiene, to circumstances of erection and constructional limitation.

Throughout the period of the Renaissance attempts have been made to use Doric, Ionic, and Corinthian orders in buildings which did not naturally give rise to these features. An almost unlimited amount of ingenuity has been expended in finding attractive variations of these orders and using them in such a way that they allowed the building to be planned for its intended purpose. It is possible that the day of the Renaissance is passing and that a period of more original design is at hand. It may be that the advent of new developments in steel and concrete were needed to provide an impetus of sufficient importance for the designer to cast off the restrictions imposed by tradition and to produce new forms and new compositions which would arise naturally from the whole of the conditions governing the production of a building.

The immense importance of this movement it is impossible to overestimate : it represents a new and a live attitude towards design ; it represents an amount of originality of thought which has not been called into being at any period since the Greeks evolved a perfect architecture of masonry and the Romans evolved an ability to solve constructional problems which to them were of unprecedented magnitude.

It would appear that contemporary designers are asked to handle problems of constructional evolution which when studied from these viewpoints are more modern and more new, more complicated and almost as unknown as those of any period of architectural history.

The outstanding feature of modern scientific and artistic development is, of course, its rapidity. In an extremely small space of time invention has followed invention.

ARCHITECTURAL DESIGN IN CONCRETE

Steel has followed cast iron, Portland cement has supplanted lime, and invention has invaded the realm of building and affected almost every unit which the architect is called upon to handle.

This rapid development is exceedingly difficult to follow and difficult to visualise in its entirety and its endless ramifications.

Tradition has for so long been a completely reliable standard that the human mind is somewhat at a loss when it is entirely deprived of the solid support of its well-known forms. Thus, of necessity, the design of concrete structures must first break away from all forms of imitation. It cannot still conform to either classic or mediæval precedent and at the same time give due weight and importance to window space and floor heights.

If they are to be real buildings of the twentieth century, these concrete buildings must develop upon lines which are in accordance with the best artistic thought of the period. The governing principles of the art of the present century are undoubtedly developing upon lines of simplicity, logic, and directness; design must embrace strong contrast and interesting surfaces.

Colour is being used to an extent which has been more or less unknown for a very considerable period, and, above all, the best work is achieving strong personality which is such an outstanding feature of this age.

No longer do nations progress as bodies of people, thinking in common, living in common, aiming at one and the same object. It is accepted that every man and every woman has an outlook which is individual, that there are differences of thought, differences of idea, differences of personality which in themselves are valuable and attractive. This attitude of mind is reflected in every walk of life, and must therefore of necessity find its counterpart in building. Thus there is a real value in the building which is original without being eccentric, and personal design will probably have more and more value as this view develops.

It is therefore of the greatest possible importance that at frequent intervals a survey should be made of the efforts of the individual designer to produce façades, interiors, colour compositions, textures, and ornament which represent his personal ideas. It must, under this system, be left for each architect to form his own views of the success or failure of contemporary work, and by means of the illustrations in this book it is hoped that many will be able to take stock of the development of concrete building for the last twenty years and to see for themselves the direction in which design is travelling; thereafter to produce designs of their own which will add one more link in the chain of development which will lead to the complete evolution of modern ideals in concrete design.

ARCHITECTURAL DESIGN IN CONCRETE

Note.—The illustrations in this book have been compiled by Mr. F. R. Yerbury, Secretary of the Architectural Association, who wishes to acknowledge his special indebtedness for assistance rendered him in Berlin by Dr. Werner Hegeman, in New York by Mr. C. H. Whittaker, and by the American Portland Cement Association, who placed their collection of photographs at his disposal, and to various architects in England and other countries who gave facilities for acquiring illustrations of their work or for taking special photographs.

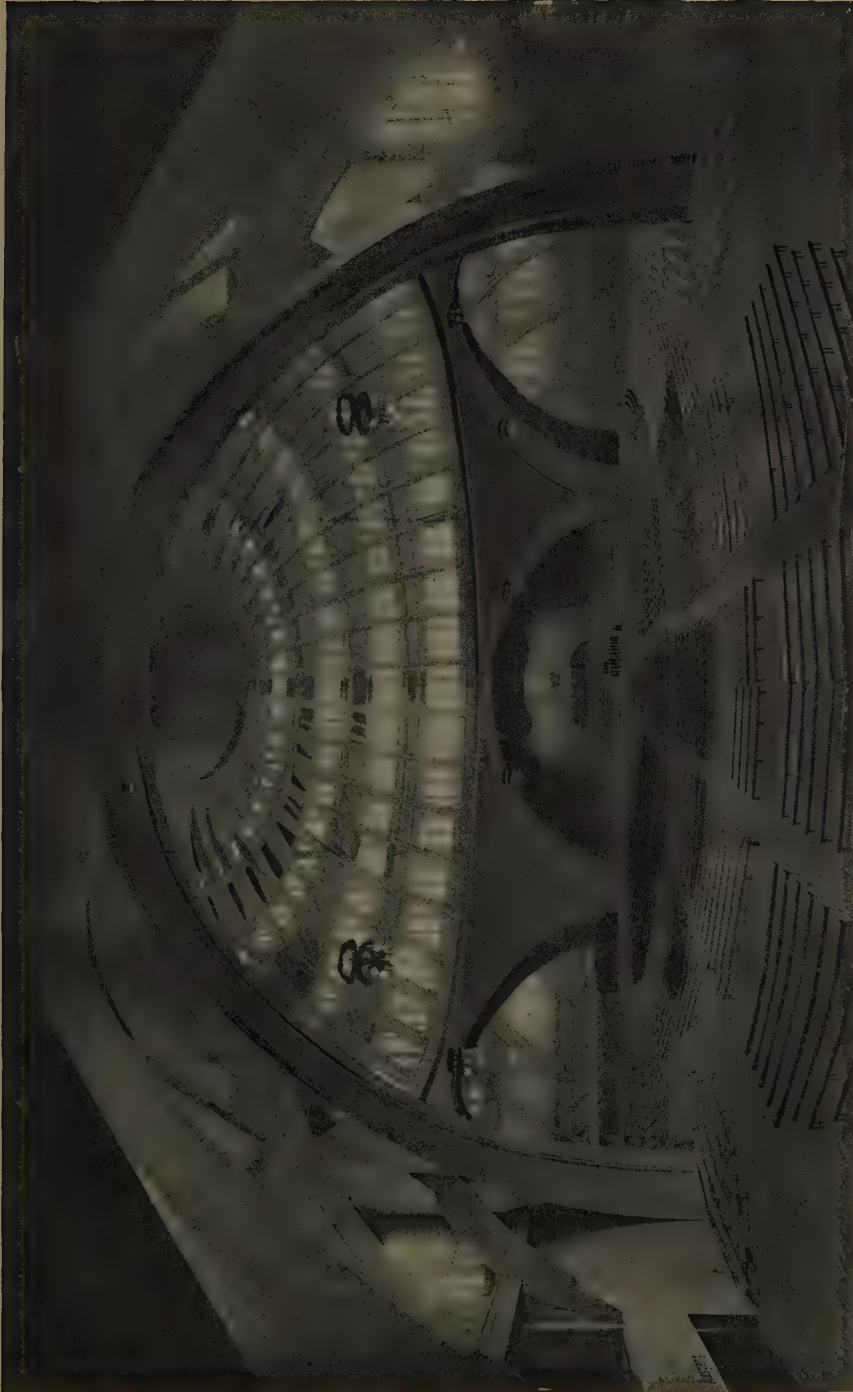
PLATES



BRESLAU, GERMANY. CENTENNIAL HALL.

Arch.: Max Berg.

BRESLAU. JAHRHUNDERTHALLE, ANSICHT VOM FLUSSE.



BRESLAU, GERMANY. CENTENNIAL HALL, INTERIOR.

Arch.: Max Berg.

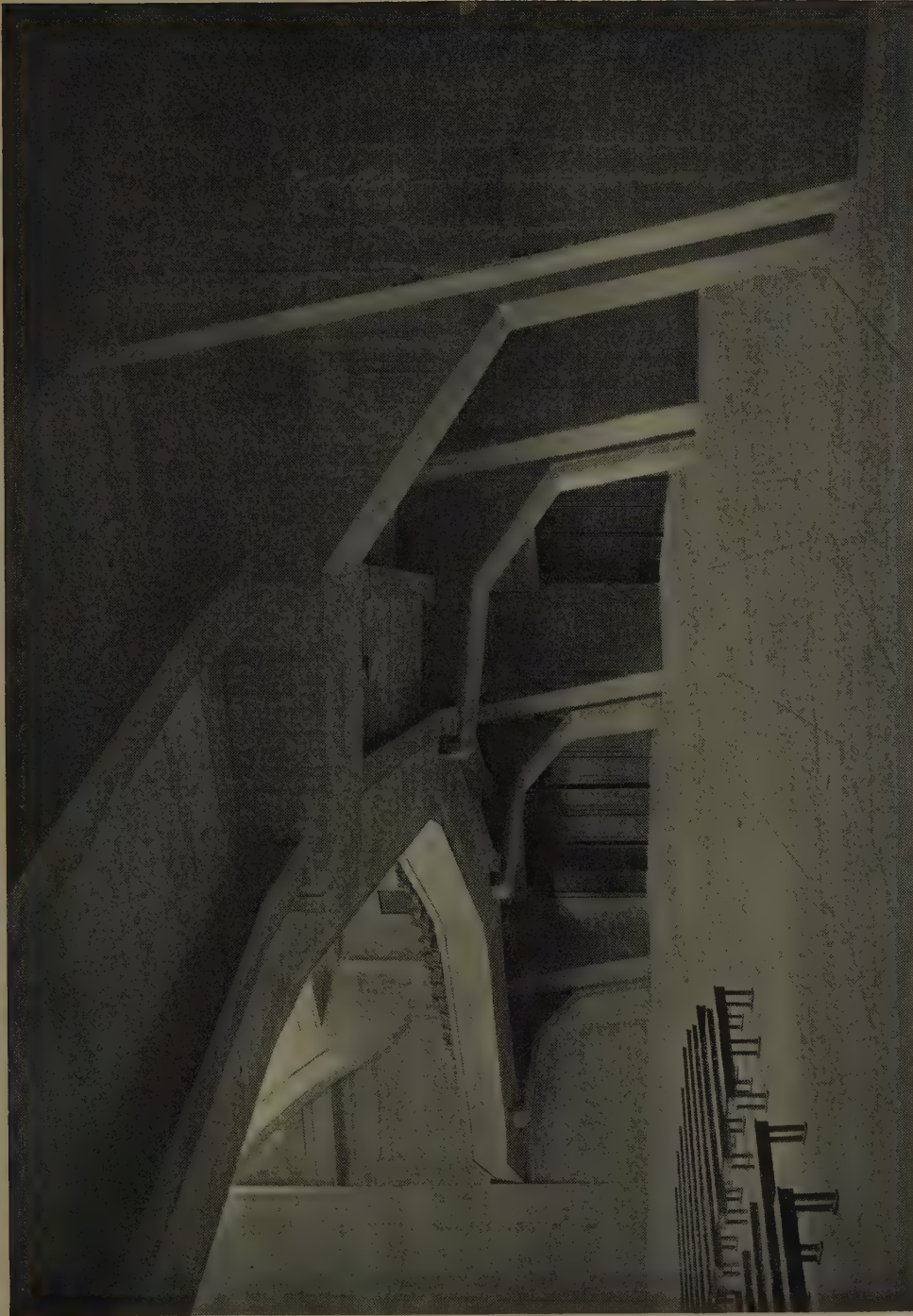
BRESLAU, JAHRHUNDERTHALLE, INNENANSICHT.



BRESLAU, GERMANY. CENTENNIAL HALL,
DETAIL OF INTERIOR.

BRESLAU. JAHRHUNDERTHALLE,
TEILANSICHT DES INNERN.

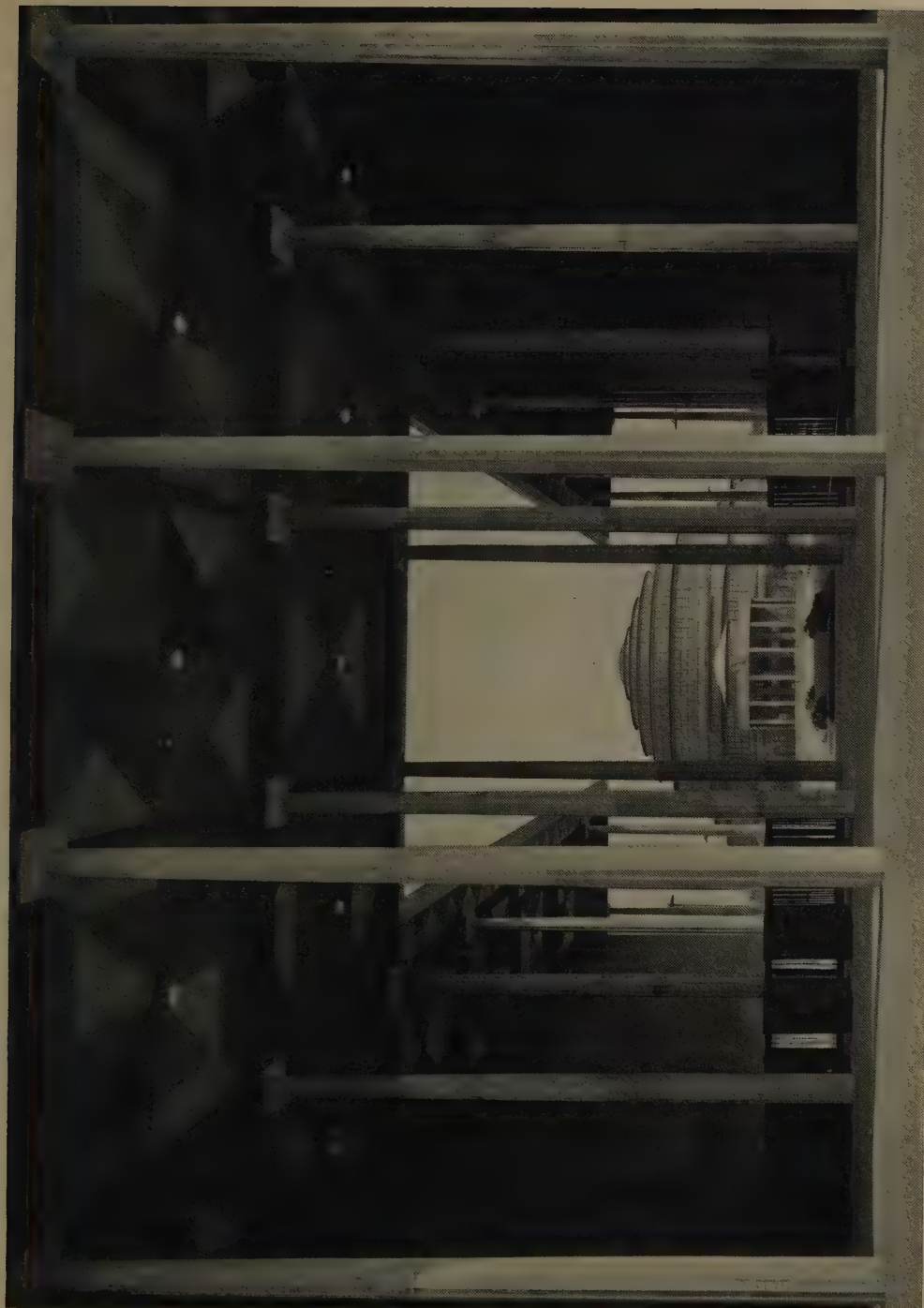
Arch.: Max Berg.



BRESLAU, GERMANY. CENTENNIAL HALL,
GALLERY SUPPORTS

BRESLAU, JAHRHUNDERTHALLE,
KONSOLEN DER GALERIEN.

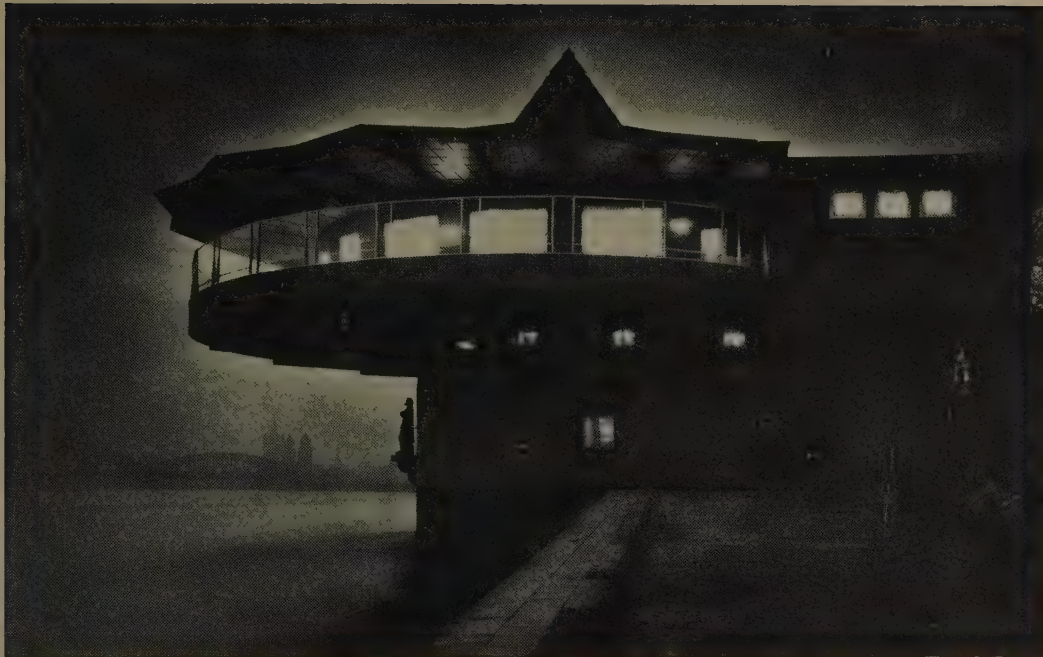
Arch.: Max Berg.



BRESLAU, GERMANY. ENTRANCE TO CENTENNIAL HALL.

Arch.: Max Berg.

BRESLAU. HAUPTTEINGANG ZUR JAHRHUNDERTHALLE.



COLOGNE, GERMANY. RESTAURANT BUILT
OVER TOWER OF OLD FORT.

KÖLN AM RHEIN. RHEINRESTAURANT "DIE BASTEL."
UMBAU EINES ALTEN FESTUNGSTURMES. NACHTAUFNAHMEN.

Arch.: Wilhelm Riphahn



LEIPZIG, GERMANY, FAIR EXHIBITION HALL.
ASSOCIATION OF GERMAN TOOL MANUFACTURERS.

LEIPZIG, MESSEHALLE DES VEREINS DEUTSCHER.
WERKZEUGMASCHINEN-FABRIKEN.

Arch.: Baurat Pusch.



LEIPZIG, GERMANY. ANNUAL FAIR, ENTRANCE HALL,
EXHIBITION HALL, ASSOCIATION OF GERMAN
TOOL MANUFACTURERS.

LEIPZIG. MESSEHALLE DES VEREINS
DEUTSCHER WERKZEUGMASCHINEN-FABRIKEN.
EINGANGSRAUM.

Arch.: Baurat Pusch.



COLOGNE, GERMANY. EXHIBITION STRUCTURE
BUILT TO DEMONSTRATE STRENGTH OF CONCRETE.

KÖLN AM RHEIN. BRÜCKENSÄULE AUF
DEM MESSEGELEND (35 m HOCH).

Arch.: Wahl & Röder.



WEMBLEY, ENGLAND. PAVILION,
BRITISH EMPIRE EXHIBITION.

WEMBLEY, ENGLAND. AUSSTELLUNGSHALLE
BRITISCHE-REICHAUSSTELLUNG.

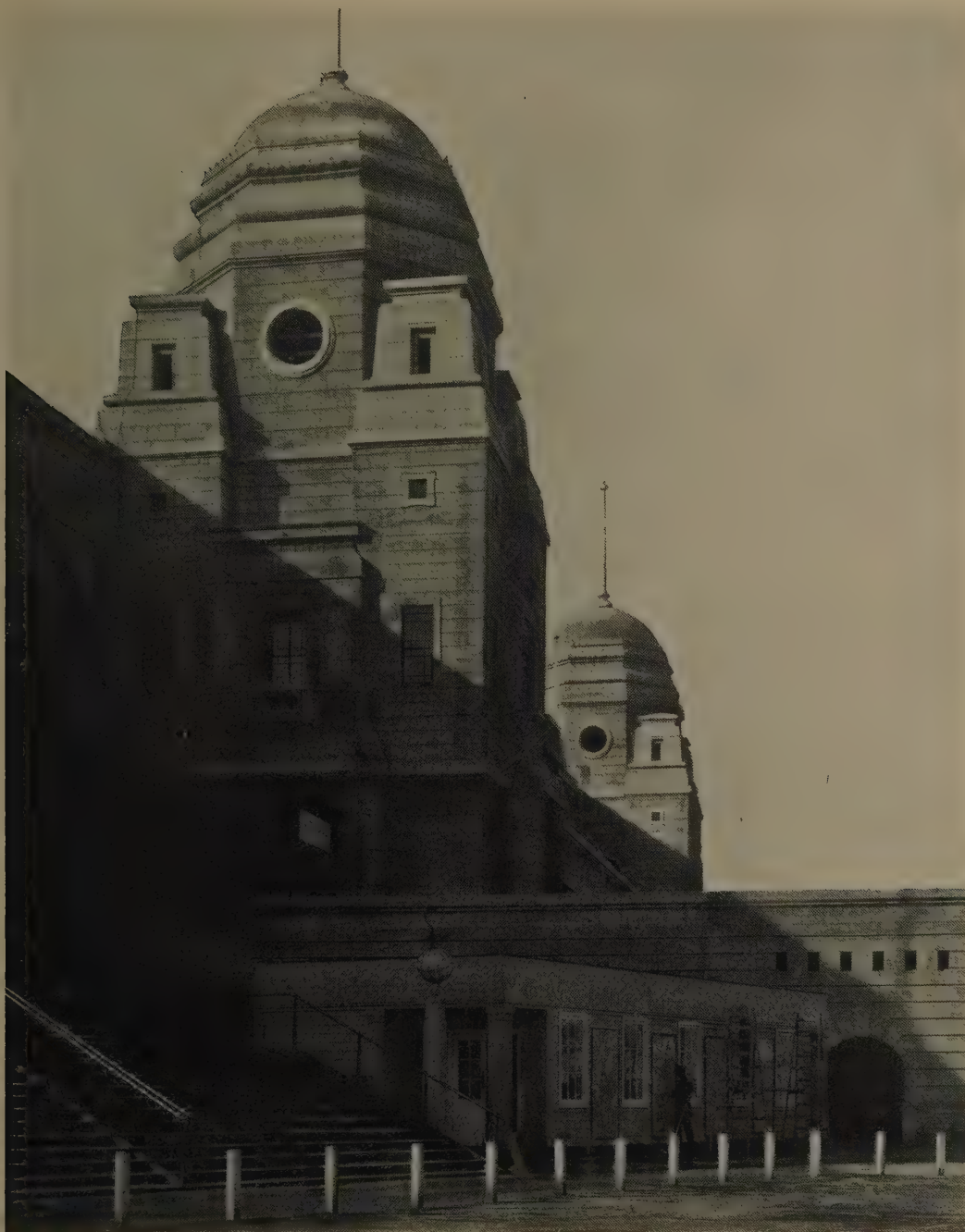
Arch.: Sir John Simpson & Maxwell Ayrton.



WEMBLEY, ENGLAND. PAVILION,
BRITISH EMPIRE EXHIBITION.

WEMBLEY, ENGLAND. AUSSTELLUNGSHALLE
BRITISCHE-REICHAUSSTELLUNG.

Arch.: Sir John Simpson & Maxwell Ayrton.



WEMBLEY, ENGLAND. BRITISH EMPIRE
EXHIBITION STADIUM.

WEMBLEY, ENGLAND. BRITISCHE-
REICHAUSSTELLUNG STADION.

Arch.: Sir John Simpson & Maxwell Ayrton.



RAMSGATE, ENGLAND. PAVILION,
ORNAMENTAL GARDENS.

RAMSGATE, ENGLAND. GARTENHAUS,
ZIERGARTEN.

Arch.: Sir John Burnet & Partners.



RAMSGATE, ENGLAND. PAVILION,
ORNAMENTAL GARDENS.

RAMSGATE, ENGLAND. GARTENHAUS,
ZIERGARTEN.

Arch.: Sir John Burnet & Partners.



RAMSGATE, ENGLAND. ORNAMENTAL GARDENS.

RAMSGATE, ENGLAND. ZIERGARTEN.

Arch.: Sir John Burnet & Partners.



RAMSGATE, ENGLAND. ORNAMENTAL GARDENS.

RAMSGATE, ENGLAND. ZIERGARTEN.

Arch.: Sir John Burnet & Partners.



SAN DIEGO, CALIFORNIA, U.S.A.
MONUMENT, BALBOA PARK.

SAN DIEGO, KALIFORNIEN, U.S.A.
DENKMAL IM BALBOA PARK.

Arch: Wm. Temple Johnson & Robert W. Snyder.



SAN DIEGO, CALIFORNIA, U.S.A. BALBOA
PARK, FINE ARTS BUILDING.

SAN DIEGO, KALIFORNIEN, U.S.A. BALBOA
PARK, KUNSTAUSSTELLUNGS-GEBÄUDE.

Arch.: Wm. Temple Johnson & Robert W. Snyder.



LOS ANGELES, CALIFORNIA, U.S.A.
CHURCH OF ST. JOHN.

LOS ANGELES, KALIFORNIEN, U.S.A.
JOHANNESKIRCHE.

Arch.: Pierpont & Walter Davis.



LOS ANGELES, CALIFORNIA, U.S.A.
CHURCH OF ST. JOHN.

LOS ANGELES, KALIFORNIEN, U.S.A.
JOHANNESKIRCHE.

Arch.: Pierpont & Walter Davis.



LOS ANGELES, CALIFORNIA, U.S.A.
ST. VINCENT'S CHURCH.

Arch. : Albert C. Martin.

LOS ANGELES, KALIFORNIEN, U.S.A.
VINZENSKIRCHE.



LOS ANGELES, CALIFORNIA, U.S.A. WILSHIRE
BOULEVARD CHURCH.

LOS ANGELES, KALIFORNIEN, U.S.A. KIRCHE
AM WILSHIRE BOULEVARD.

Arch.: Allison & Allison.



LOS ANGELES, CALIFORNIA, U.S.A.
ST. PAUL'S CATHEDRAL.

LOS ANGELES, KALIFORNIEN, U.S.A.
DOM ZU ST. PAUL.

Arch.: Johnson, Kauffman & Coate.



PARIS, FRANCE. LE RAINCY CHURCH.

PARIS, FRANKREICH. KIRCHE LE RAINCY.

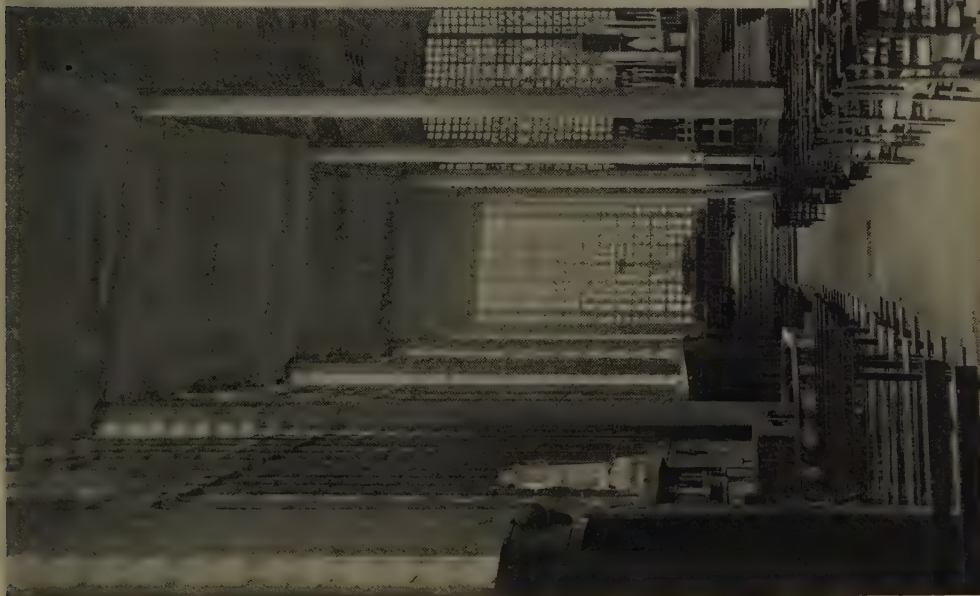
Arch.: A. & Gs Perret.



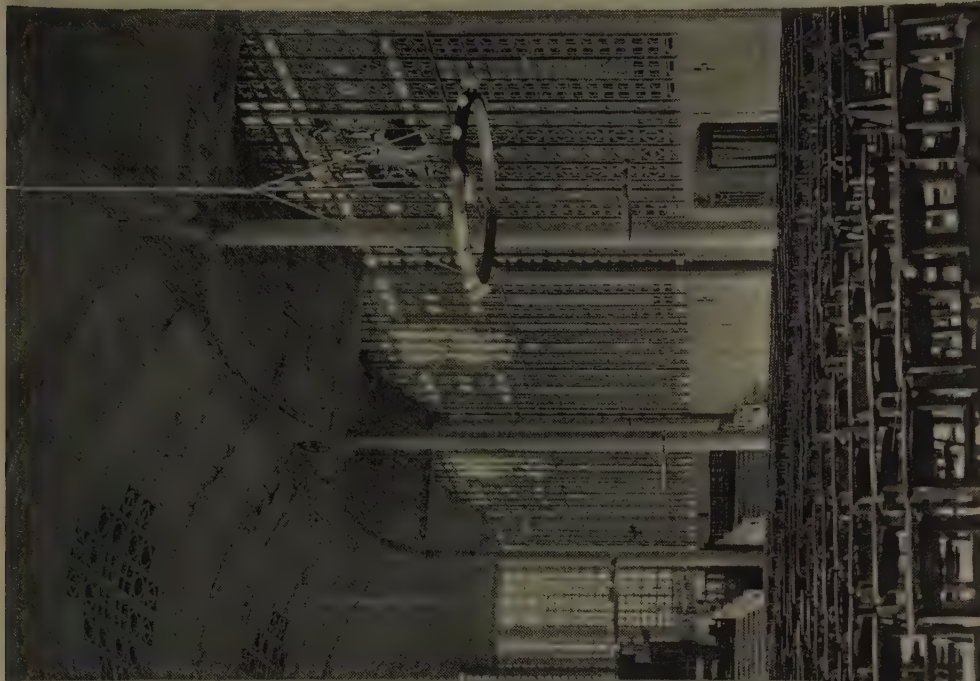
PARIS, FRANCE. LE RAINCY CHURCH.

PARIS, FRANKREICH. KIRCHE LE RAINCY.

Arch.: A. & G. Perret.

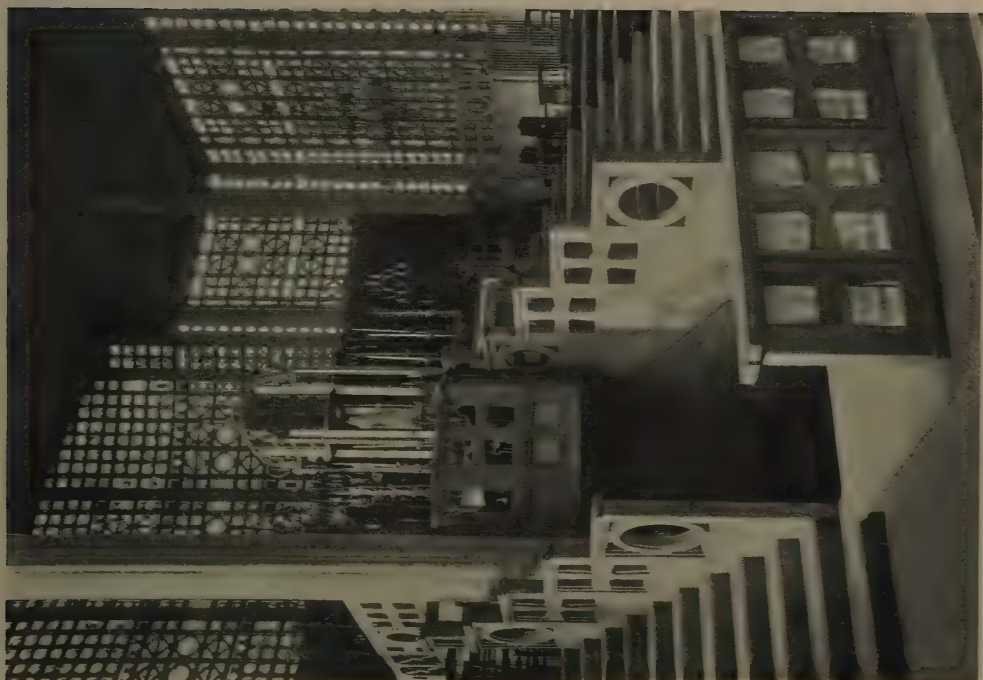


PARIS, FRANCE. LE RAINCY CHURCH.



PARIS, FRANKREICH. KIRCHE LE RAINCY.

Arch.: A. & G. Perret.

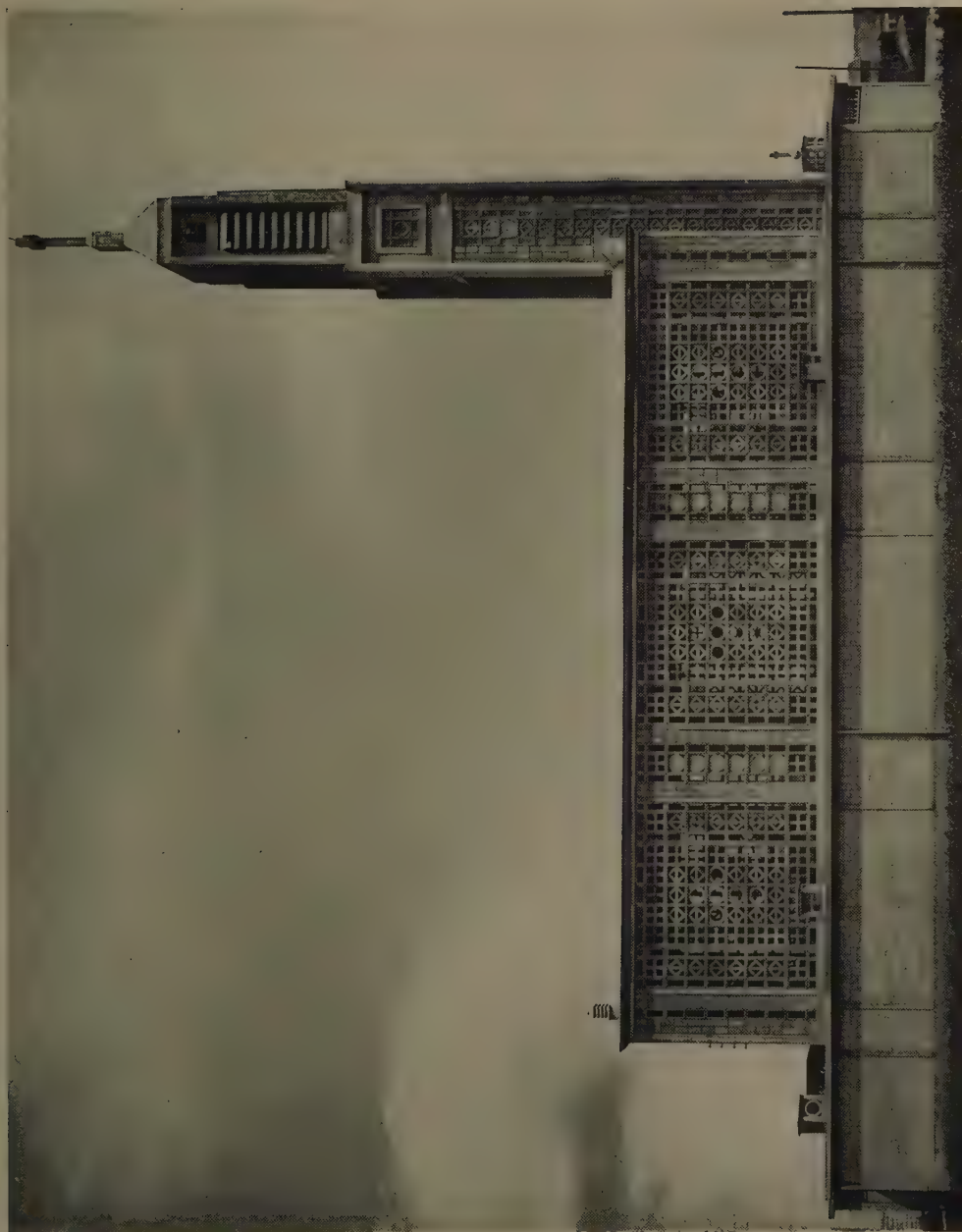


PARIS, FRANCE. LE RAINCY CHURCH.

Arch.: A. & G. Perret.



PARIS, FRANCE. LE RAINCY CHURCH.



PARIS, FRANCE. CHURCH OF ST. DENIS.

Arch.: A. & G. Perret.

PARIS, FRANKREICH. KIRCHE ST. DENIS.



PARIS, FRANCE. CHURCH OF ST. DENIS.

PARIS, FRANKREICH. KIRCHE ST. DENIS.

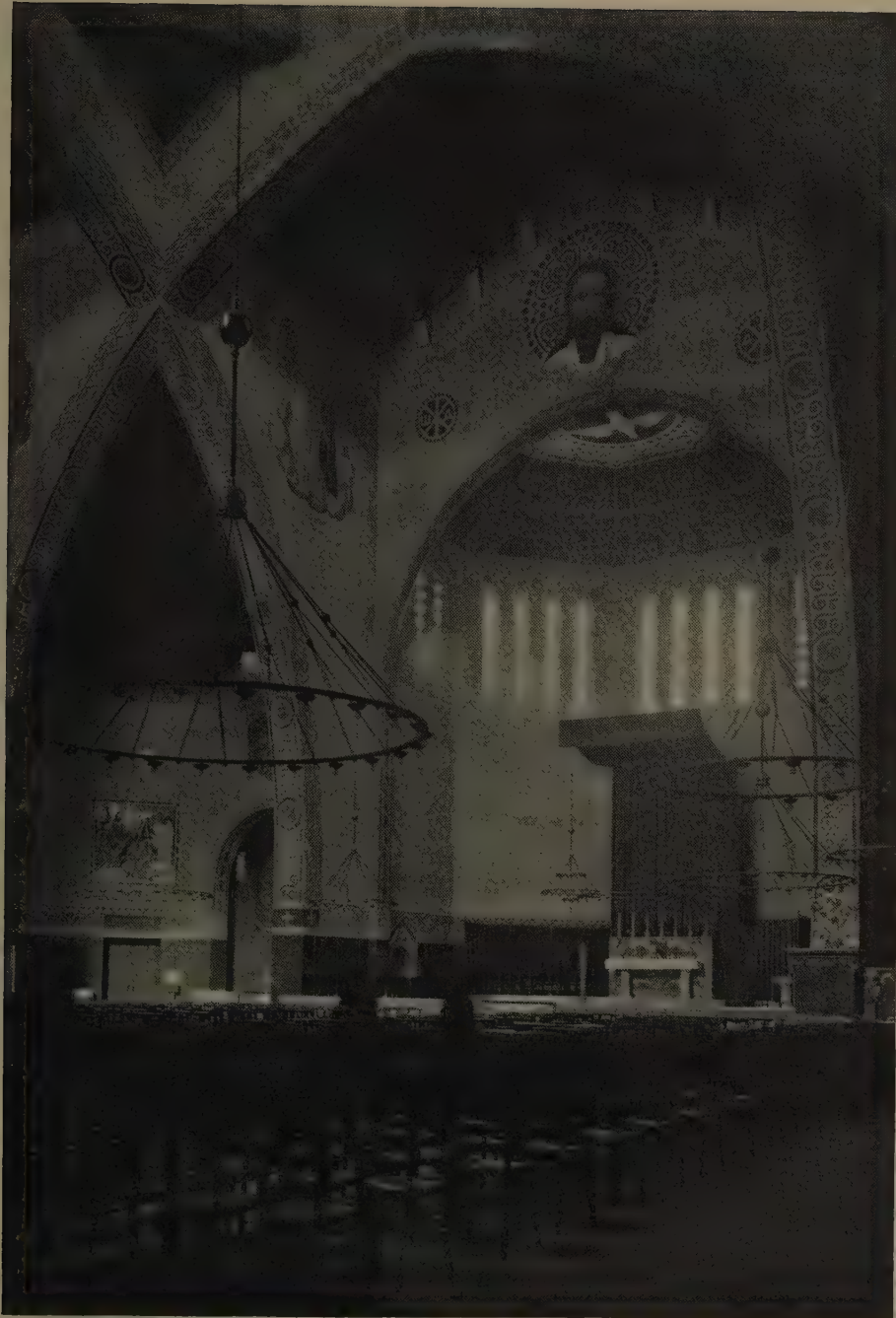
Arch.: A. & G. Perret.



VINCENNES, PARIS. CHURCH. (OUTER COVERING IN BRICK, WITH CONCRETE TRACERIED WINDOWS.)

VINCENNES, PARIS. KIRCHE. (AUSSEN MIT ZIEGELN VERKLEIDET, FENSTERMASSWERK AUS BETON.)

Arch.: J. Marast.



VINCENNES, PARIS. CHURCH.

Arch.: J. Marast.

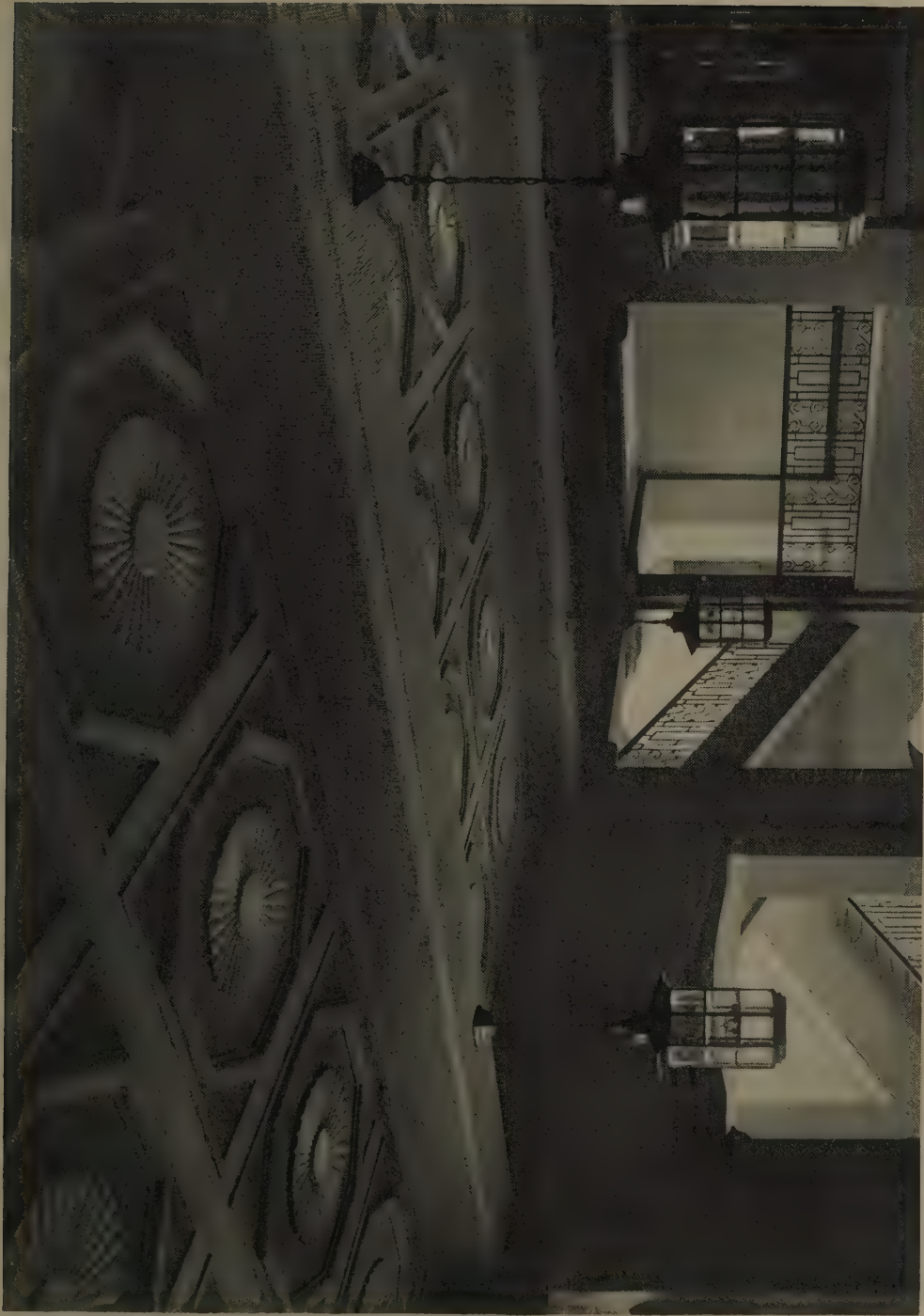
VINCENNES, PARIS. KIRCHE.



HAMBURG, GERMANY. "GEWERBEHAUS,"
MAIN STAIRCASE.

HAMBURG. HAUPTTREPPENHAUS
IM GEWERBEHAUS.

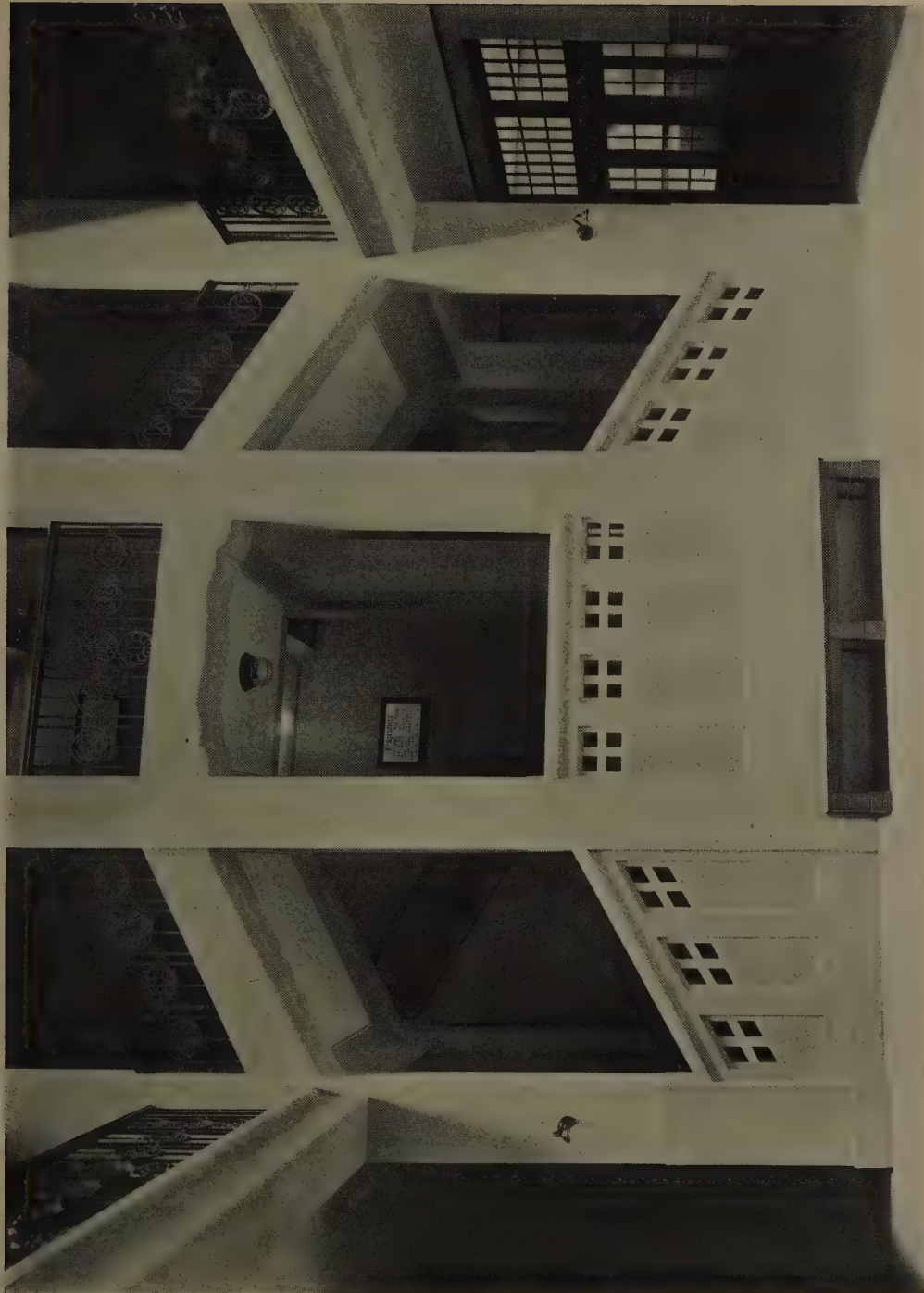
Arch.: Professor Fritz Schumacher.



HAMBURG, GERMANY. "GEWERBEHAUS,"
CEILING OF MAIN STAIRCASE.

Arch.: Professor Fritz Schumacher.

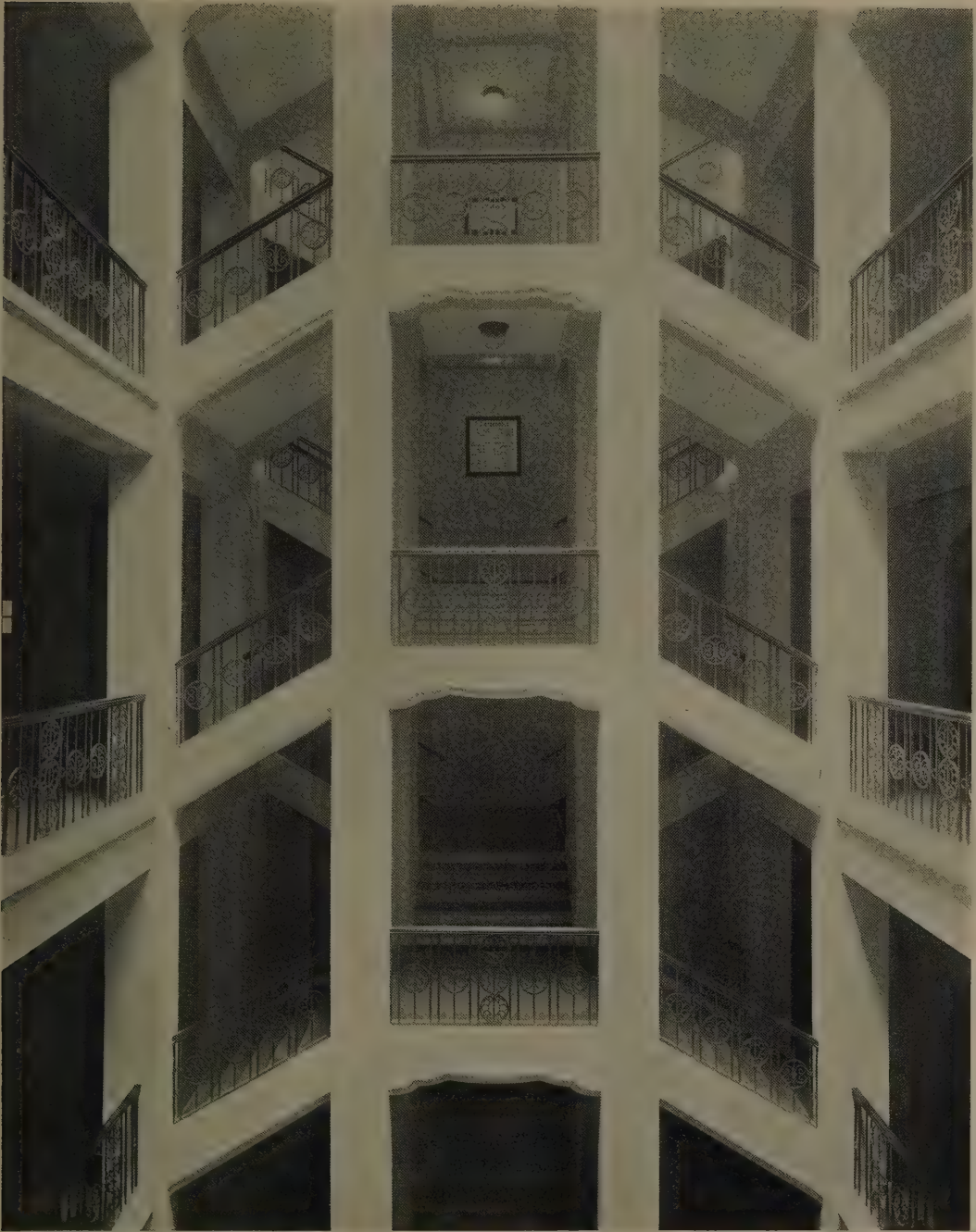
HAMBURG. DECKE IM HAUPTTREPPENHAUS
DES GEWERBEHAUSES.



HAMBURG, GERMANY. "GEWERBEHAUS,"
STAIRCASE DETAIL.

Arch.: Professor Fritz Schumacher.

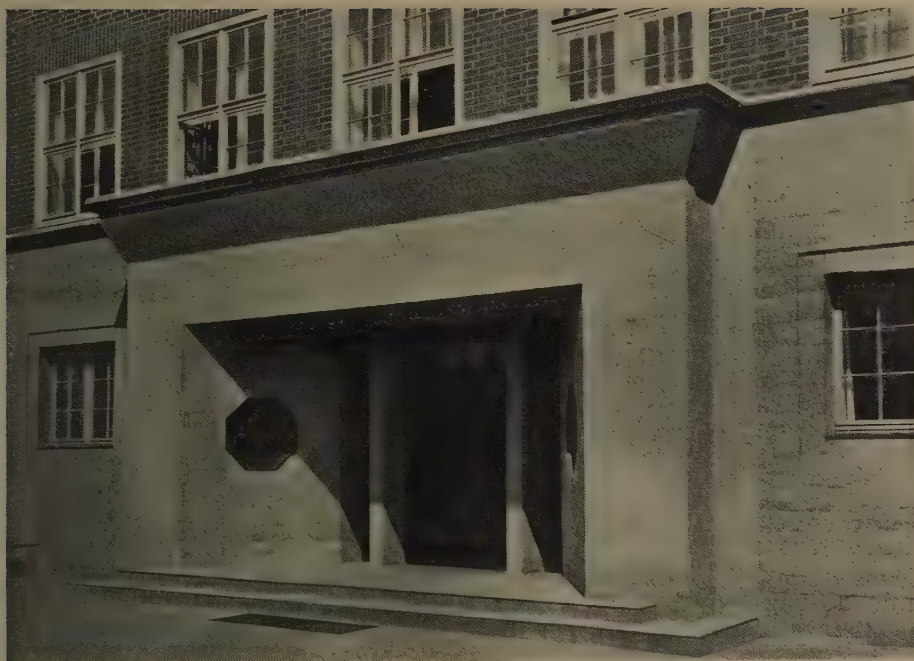
HAMBURG. NEBENTREPPPE IM
GEWERBEHAUS.



HAMBURG, GERMANY. "GEWERBEHAUS," OPEN
STAIRCASE (SEVEN STORIES).

HAMBURG. GEWERBEHAUS, NEBENTREPP
(SIEBENGESCHOSSIG).

Arch.: Professor Fritz Schumacher.



CASSEL, GERMANY. OFFICE BUILDING. ENTRANCE.

Arch.: Curt von Brocke.

CASSEL. BÜROHAUS, EINGANG.

CASSEL, GERMANY. OFFICE BUILDING,
STAIRCASE AND LANDING.

Arch.: Curt von Brocke.

CASSEL. BÜROHAUS, INNERES DES
TREPPENHAUSES.



ORLANDO, FLORIDA, U.S.A. SAN JUAN HOTEL.

ORLANDO, FLORIDA, U.S.A. HOTEL SAN JUAN

Arch.: W. L. Stoddard.



LOS ANGELES, CALIFORNIA, U.S.A. WALNUT
GROWERS' ASSOCIATION BUILDING.

LOS ANGELES, KALIFORNIEN, U.S.A. GEBÄUDE
DES WALNUSS-PFLANZERVEINS.

Arch.: Albert C. Martin.



NEW YORK CITY, U.S.A. AMERICAN
NEWS CO. BUILDING.

NEW YORK CITY, U.S.A. GEBÄUDE DER
AMERICAN NEWS CO.

Arch. : Russell T. Cory.



LOS ANGELES, CALIFORNIA, U.S.A.
HOLLYWOOD TERMINAL BUILDING.

LOS ANGELES, KALIFORNIEN, U.S.A.
BÜROGEBÄUDE IN HOLLYWOOD.

Arch.: Morgan, Walls & Clements.



LOS ANGELES, CALIFORNIA, U.S.A.
HOLLYWOOD TERMINAL BUILDING.

LOS ANGELES, KALIFORNIEN, U.S.A.
BÜROGEBAUDE IN HOLLYWOOD.

Arch.: Morgan, Walls & Clements.



LOS ANGELES, CALIFORNIA, U.S.A.
ELKS' TEMPLE.

LOS ANGELES, KALIFORNIEN, U.S.A.
ELKS' TEMPEL.

Arch. : Curlett & Beekman.



ACTON, LONDON, ENGLAND. OFFICES OF
MINISTRY OF WAR PENSIONS.

Arch.: J. G. West (H.M. Office of Works).

ACTON, LONDON, ENGLAND. BÜROGEBAUDE DES
MINISTRY OF WAR PENSIONS.



ACTON, LONDON, ENGLAND. OFFICES OF
MINISTRY OF WAR PENSIONS.

ACTON, LONDON, ENGLAND. BÜROGEBÄUDE DES
MINISTRY OF WAR PENSIONS.

Arch.: J. G. West (H.M. Office of Works).



LOS ANGELES, CALIFORNIA, U.S.A. AUTO CLUB.

Arch. : Hunt & Burns.

LOS ANGELES, KALIFORNIEN, U.S.A. AUTOMOBILCLUB.



DERBY, ENGLAND. ELECTRICITY
POWER HOUSE.

DERBY, ENGLAND. ELEKTRISCHE
KRAFTSTATION.

Arch.: Arthur Eaton & Son.



CASSEL, GERMANY. COAL BUNKER AND BOILER HOUSE.

CASSEL. KOHLENBUNKER UND KESSELHAUS.

Arch.: Curt von Brocke.



CASSEL, GERMANY. LUMBER STOREHOUSE.

CASSEL. HOLZLAGER.

Arch.: Curt von Brocke.



CASSEL, GERMANY. COAL BUNKER.

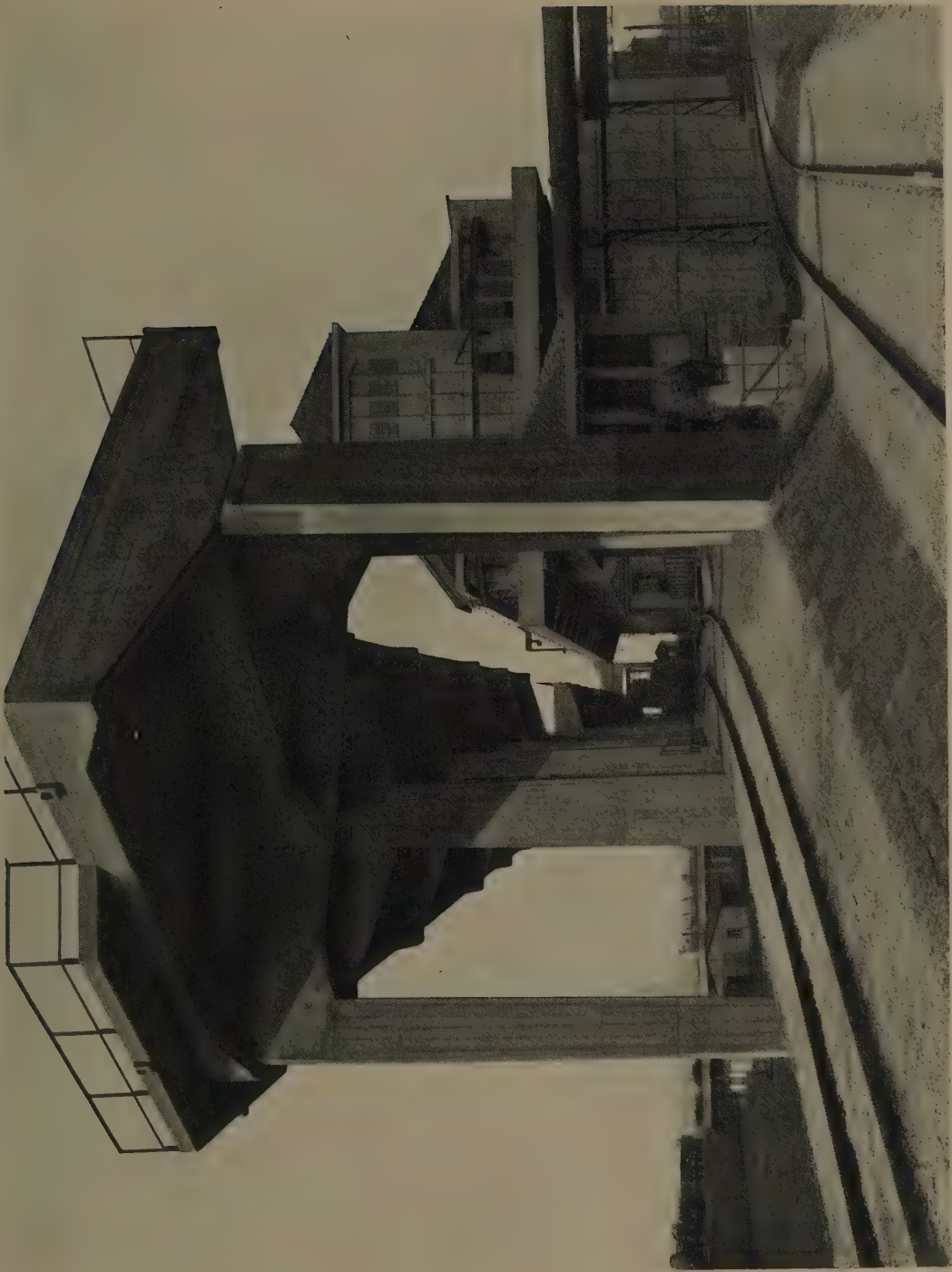
CASSEL. KOHLENBUNKER.



CASSEL, GERMANY. FACTORY, CARPENTERS' SHOP.

Arch.: Curt von Brocke.

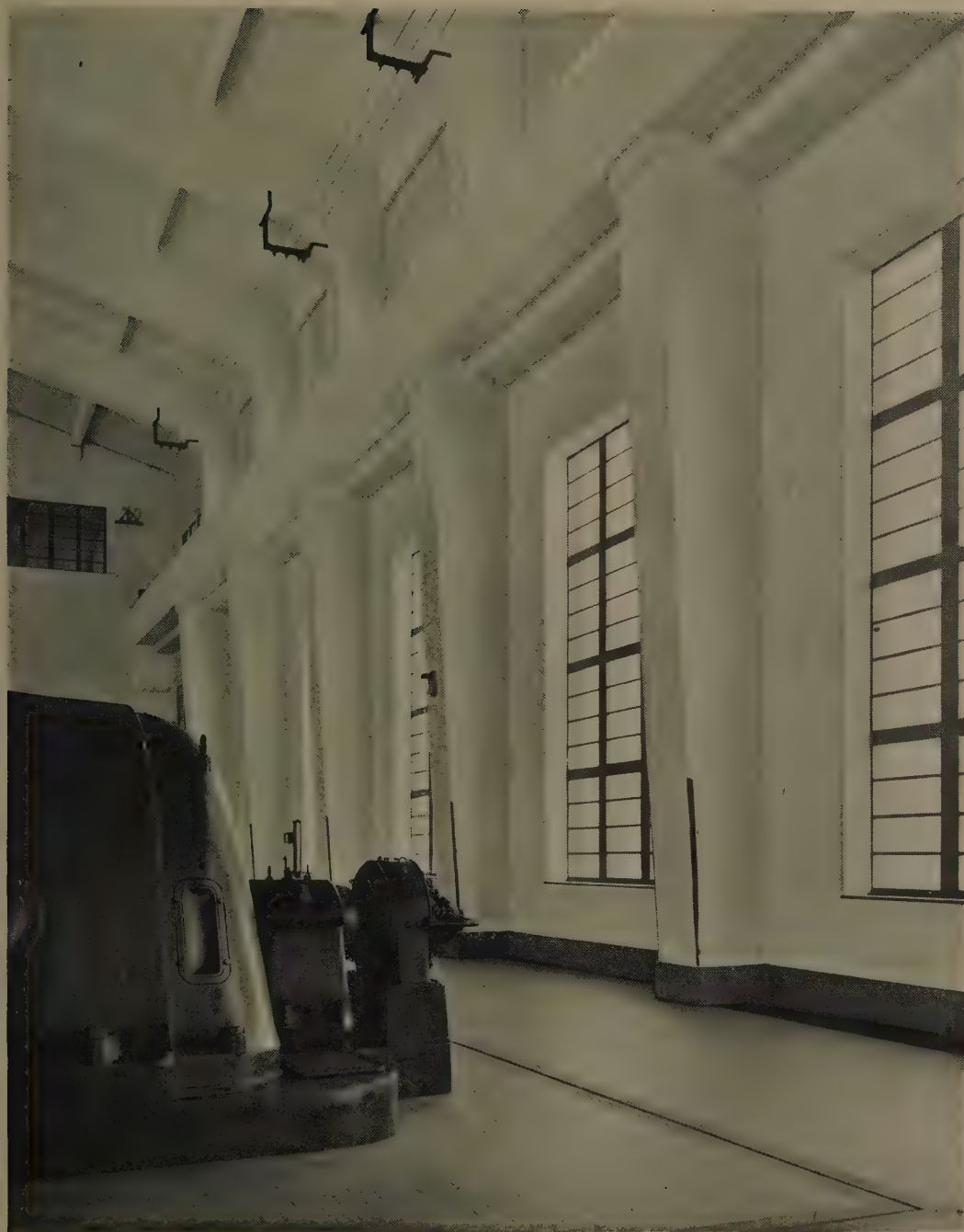
CASSEL. SCHREINEREIGEBÄUDE.



DRESDEN, GERMANY. GAS WORKS PLANT.

Arch.: Professor Hans Poelzig.

DRESDEN. GASANSTALT.



KÖNIGSBORN, GERMANY. TURBINE HOUSE.

KÖNIGSBORN. MASCHINENZENTRALE.

Arch.: Professor Alfred Fischer.



FINSING, BAVARIA. WATER POWER STATION.

FINSING (BAYERN). WASSERKRAFTWERK, BLICK DURCH DEN BOGEN.
Arch.: Professor Otto Orlando Kurz.



COPENHAGEN, DENMARK. MACHINE FITTERS' SHOP, ROYAL ARSENAL.

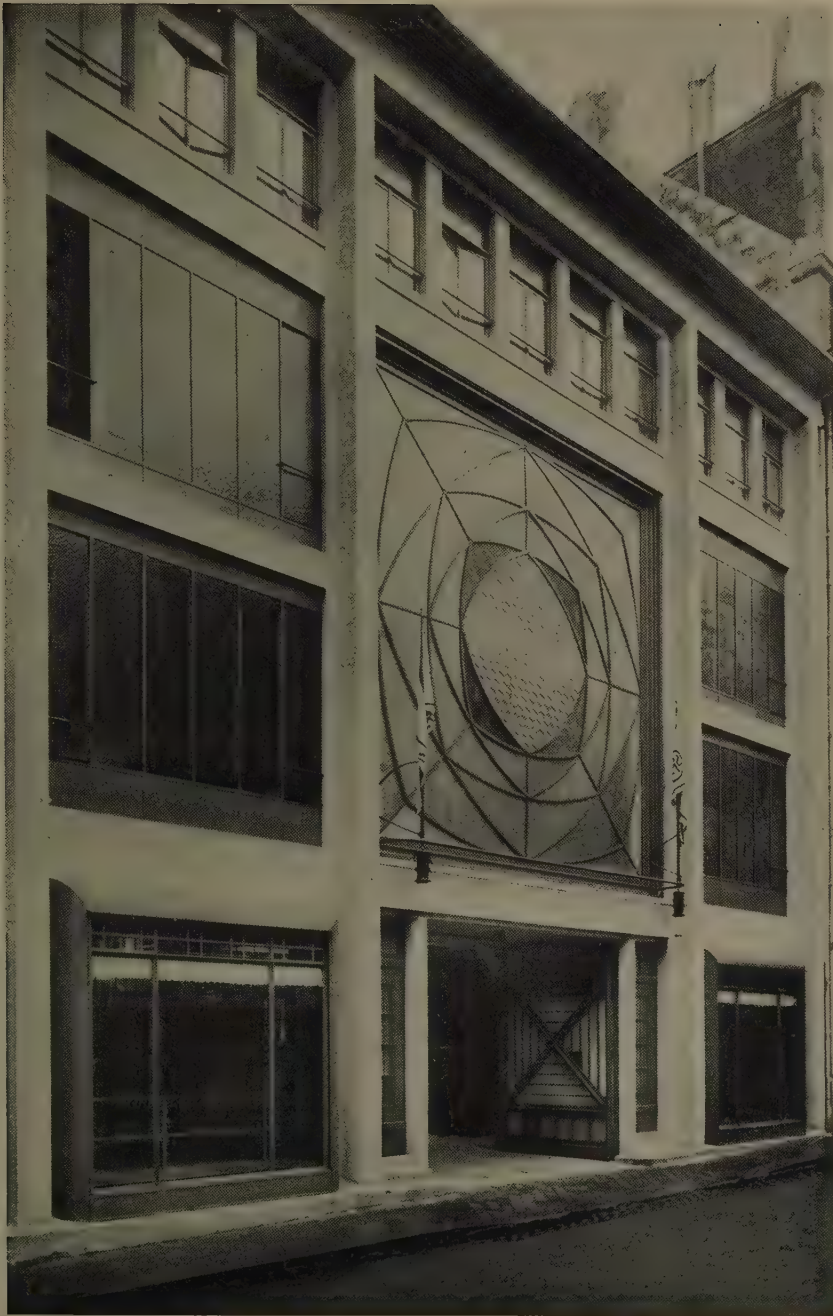
KOPENHAGEN, DÄNEMARK. FABRIKHALLE IM KGL. ARSENAL.



STOCKHOLM, SWEDEN. FACTORY.

STOCKHOLM, SCHWEDEN. FABRIK.

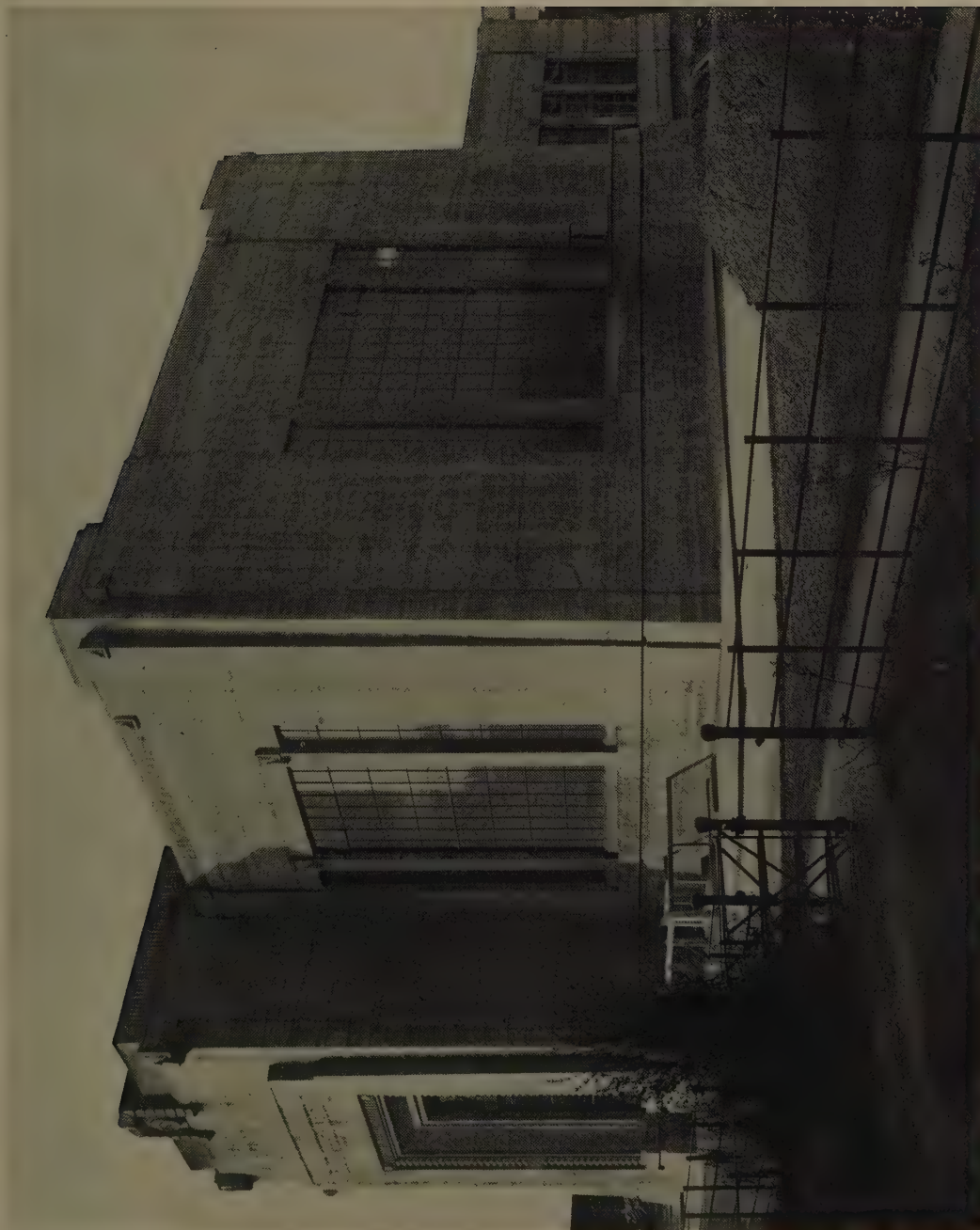
Arch.: Ture Sellman.



PARIS, FRANCE. GARAGE.

PARIS, FRANKREICH. GARAGE.

Arch.: A. & G. Perret.



PURLEY, SURREY, ENGLAND. EAST SURREY WATERWORKS.

PURLEY, SURREY, ENGLAND. EAST SURREY WATERWERKE.
Arch: Wallis, Gilbert & Partners.



WELWYN GARDEN CITY, ENGLAND. SHREDDED WHEAT FACTORY.

Arch.: L. de Soissons & A. W. Kenyon.

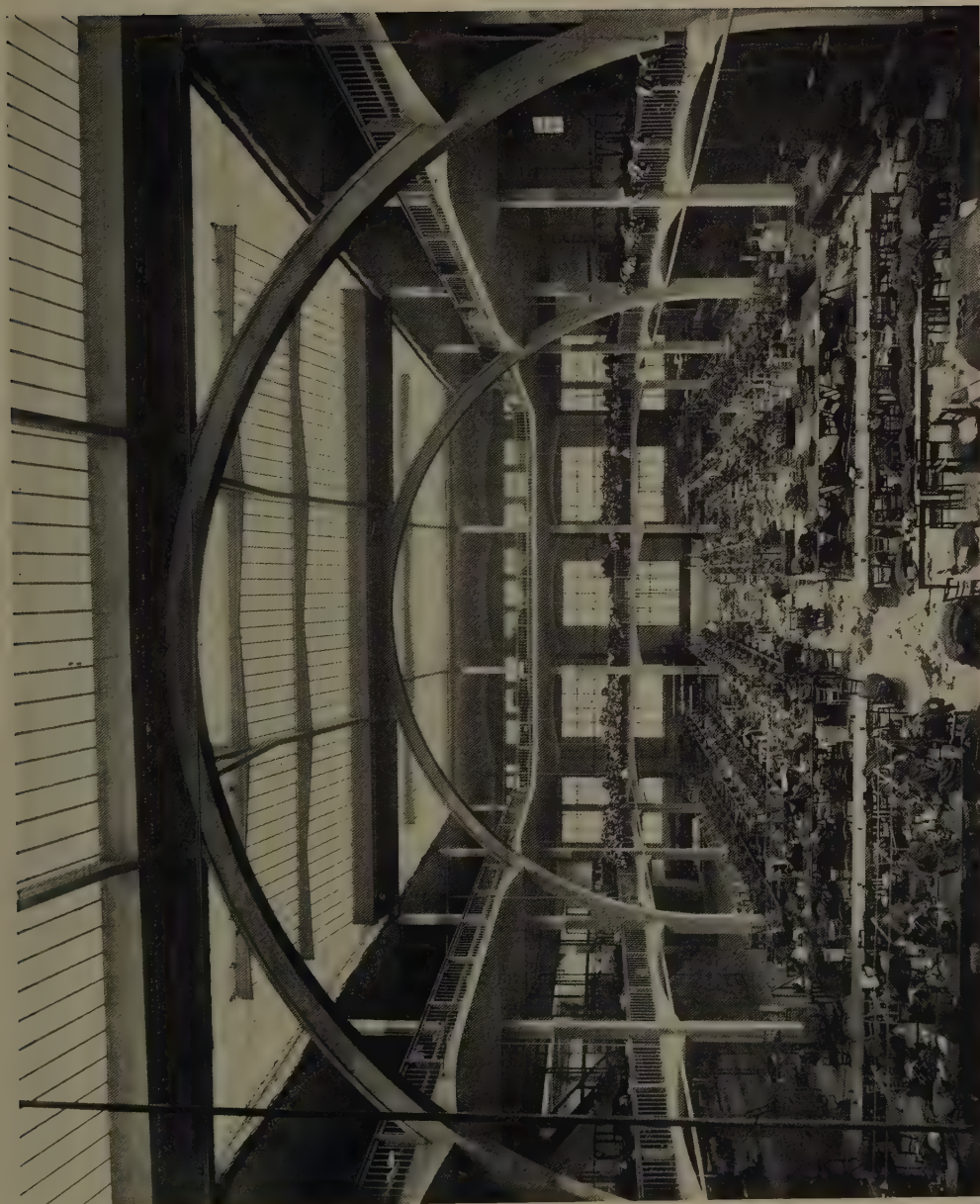
GARTENSTADT WELWYN, ENGLAND. SCHROTMEHL FABRIK.



WELWYN GARDEN CITY, ENGLAND. SHREDDED WHEAT FACTORY.

Arch.: L. de Soissons & A. W. Kenyon.

GARTENSTADT WELWYN, ENGLAND. SCHROTMEHL FABRIK.



PARIS, FRANKREICH, FABRIKGEBÄUDE.

Arch.: A. & G. Perret.

PARIS, FRANCE, FACTORY BUILDING.



MUNICH, BAVARIA. WATER TOWER, BAVARIAN
MOTOR WORKS.

MÜNCHEN. WASSERTURM DER BAYERISCHEN
MOTOREN WERKE.

Arch.: Professor Otto Orlando Kurz.



CASSEL, GERMANY. OFFICE BUILDING,
STAIRS TO ROOF.

Arch.: Curt von Brocke.

CASSEL, GERMANY. FACTORY, CARPENTERS' SHOP.

Arch.: Curt von Brocke.

CASSEL. BÜROHAUS, TREPPE ZUR
DACHSPITZE.

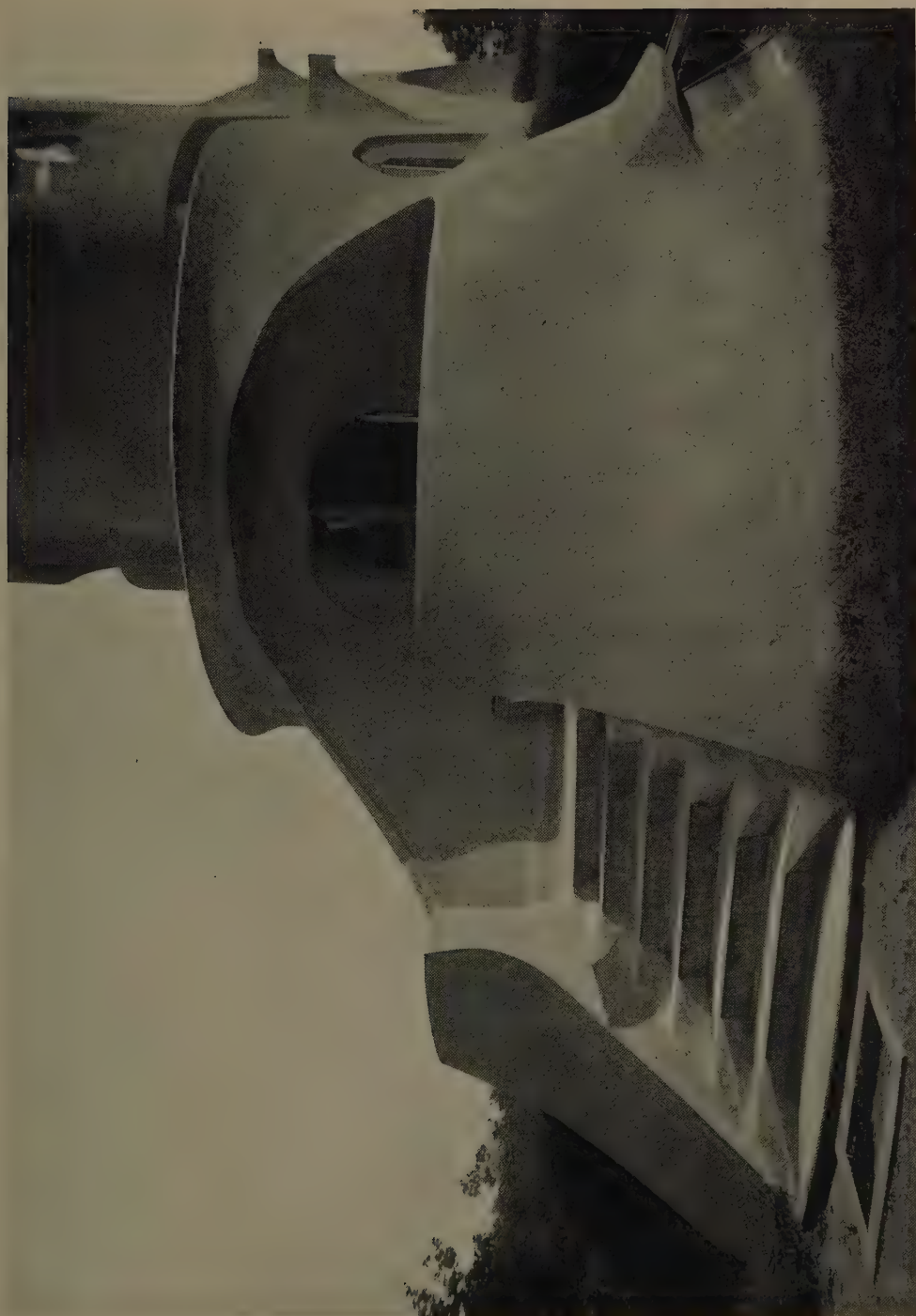
CASSEL. INNERES DER SCHREINEREI.



POTSDAM, GERMANY. EINSTEIN TOWER.

POTSDAM, DEUTSCHLAND. EINSTEINTURM.

Arch.: Erich Mendelsohn.



POTSDAM, GERMANY. EINSTEIN TOWER.

Arch.: Erich Mendelsohn.

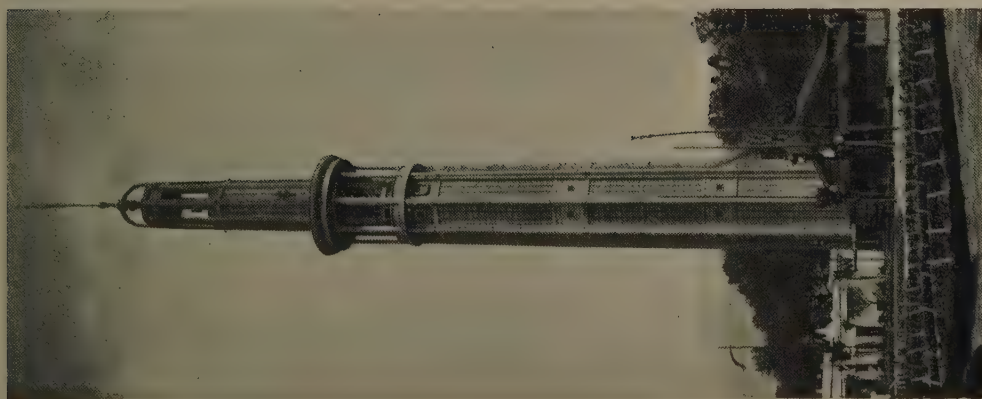
POTSDAM, DEUTSCHLAND. EINSTEINTURM.



KOOTWYK, HOLLAND. RADIO TOWER.

KOOTWYK, HOLLAND. RUNDFUNKTURM.

Arch.: J. M. Luthman.



GRENOBLE, FRANCE. OBSERVATION TOWER.
GRENOBLE, FRANKREICH. AUSSICHTSTURM.
Arch.: A. & G. Perret.



NYKJÖBING, DENMARK. WATER TOWER.

NYKJÖBING, DÄNEMARK. WASSERTURM.
Arch.: E. Ambt.



VERSAILLES, FRANCE. PRIVATE HOUSE.

VERSAILLES, FRANKREICH. EINFAMILIENHAUS.

Arch.: Andre Lurcat.



VERSAILLES, FRANCE. PRIVATE HOUSE.

Arch.: Andre Lurcat.

VERSAILLES, FRANKREICH. EINFAMILIENHAUS.



VERSAILLES, FRANCE. PRIVATE HOUSE.

Arch. : Andre Lurcat.

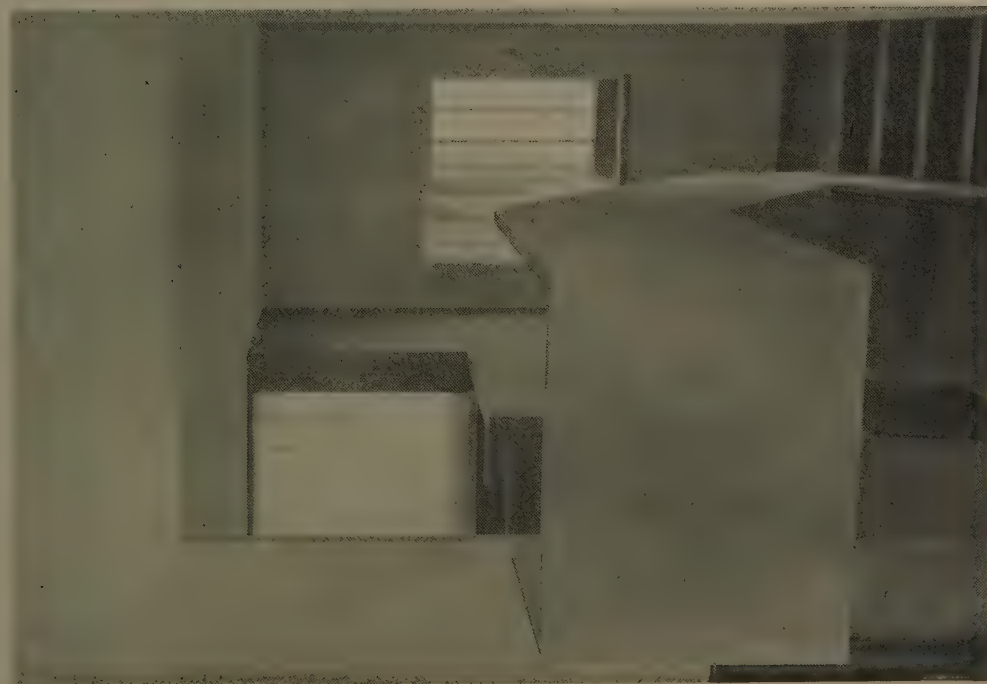
VERSAILLES, FRANKREICH. EINFAMILIENHAUS.



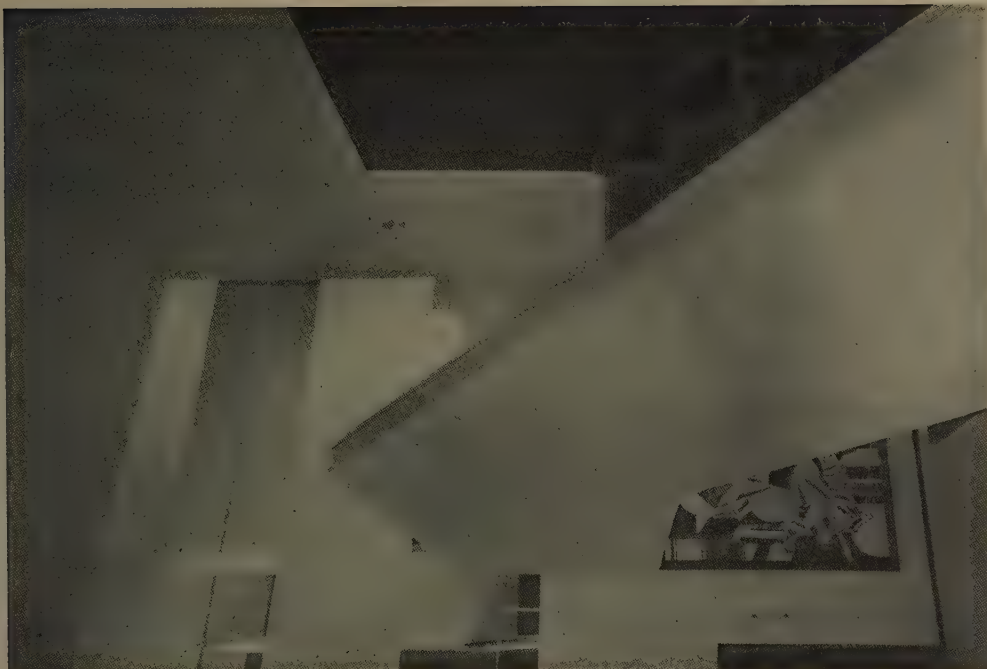
PARIS, FRANCE. PRIVATE HOUSES.

PARIS, FRANKREICH. EINFAMILIENHÄUSER.

Arch.: Le Corbusier.

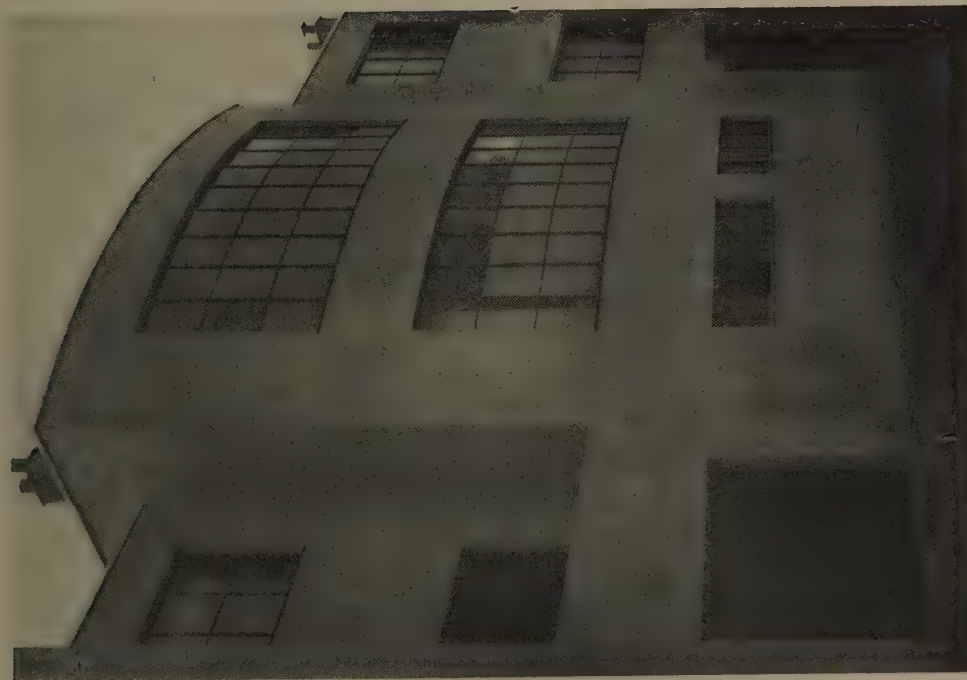


PARIS, FRANCE. HOUSE STAIRCASE.



PARIS, FRANCE. TREPPENHAUS.

Arch.: Le Corbusier.



PARIS, FRANCE.
PRIVATE HOUSE.

Arch.: Andre Lurcat.



PARIS, FRANCE.
HOUSE AND STUDIO.

Arch.: A. & G. Perret.

PARIS, FRANKREICH.
HAUS UND ATELIER.



WELWYN GARDEN CITY, ENGLAND.

Arch.: L. de Soissons & A. W. Kenyon.

GARTENSTADT WELWYN, ENGLAND.



WELWYN GARDEN CITY, ENGLAND.

Arch.: L. de Soissons & A. W. Kenyon.

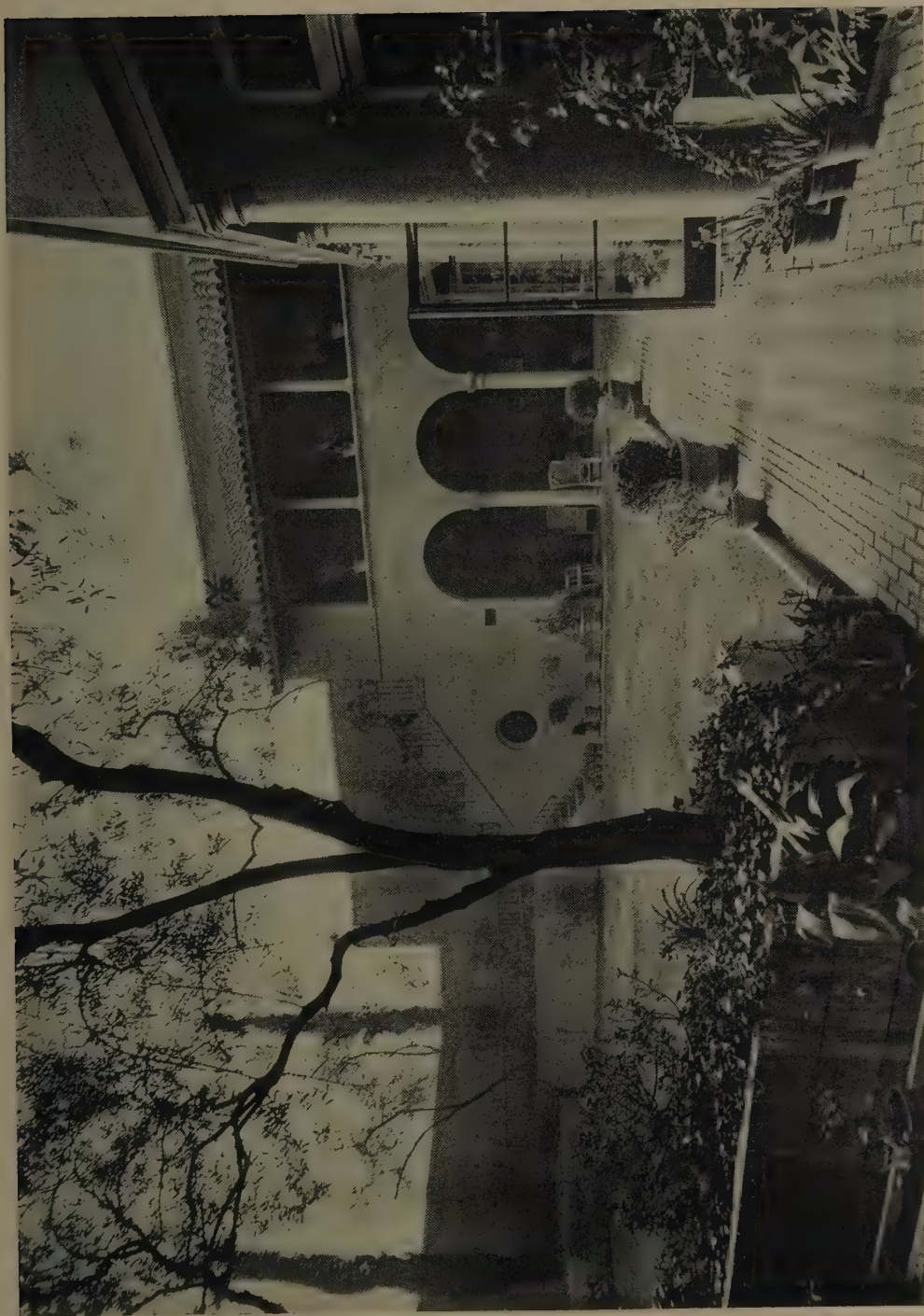
GARTENSTADT WELWYN, ENGLAND.



WELWYN GARDEN CITY, ENGLAND.

GARTENSTADT WELWYN, ENGLAND.

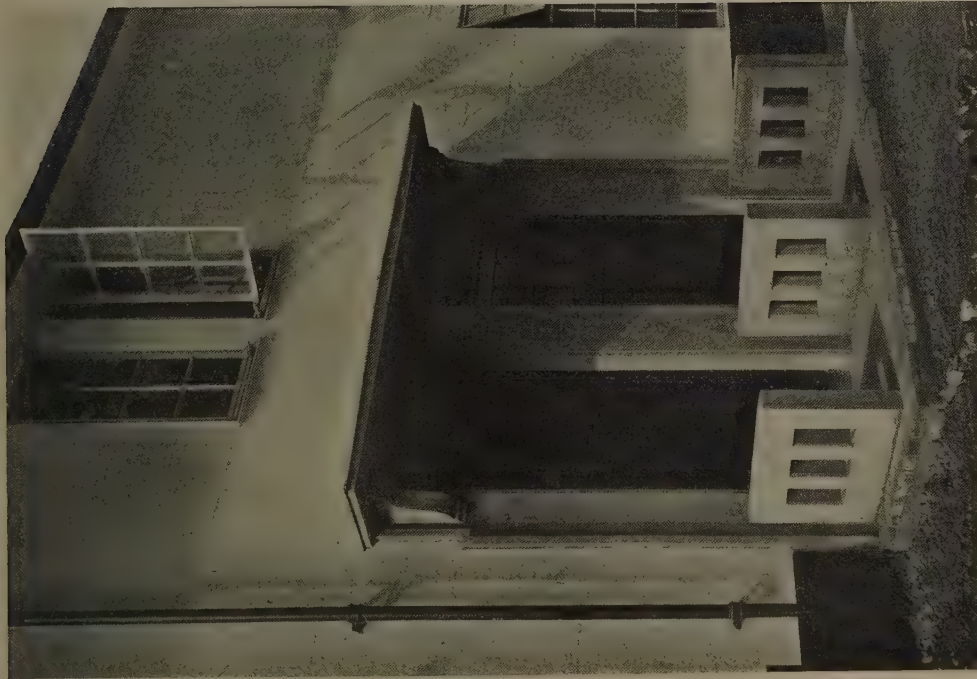
Arch.: L. de Soissons & A. W. Kenyon.



LOS ANGELES, CALIFORNIA, U.S.A.
WOMEN'S ATHLETIC CLUB.

Arch.: Allison & Allison.

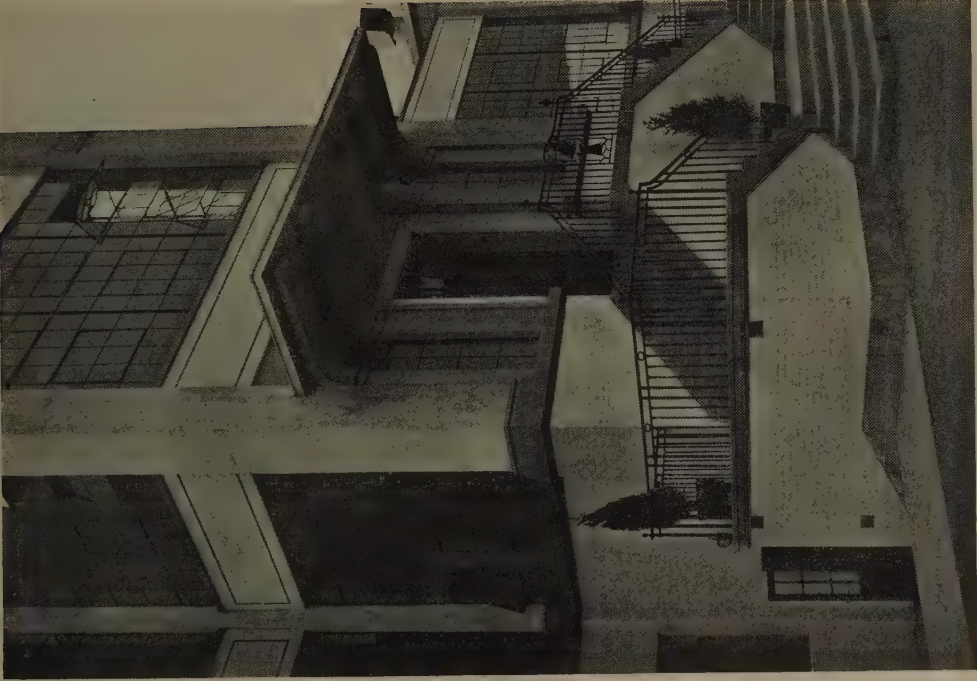
LOS ANGELES, KALIFORNIEN.
FRAUENTURNVEREIN.



WELWYN GARDEN CITY,
ENGLAND.
DOMESTIC DOORWAYS.

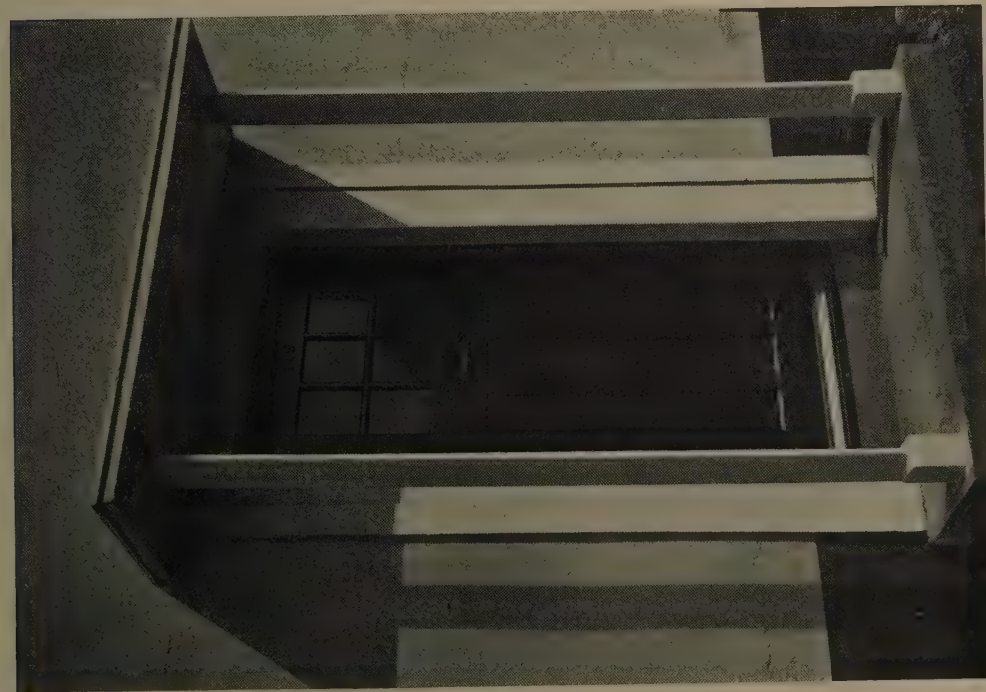
GARTENSTADT WELWYN,
ENGLAND.
HAUSTÜREN.

Arch.: L. de Soissons & A. W. Kenyon.



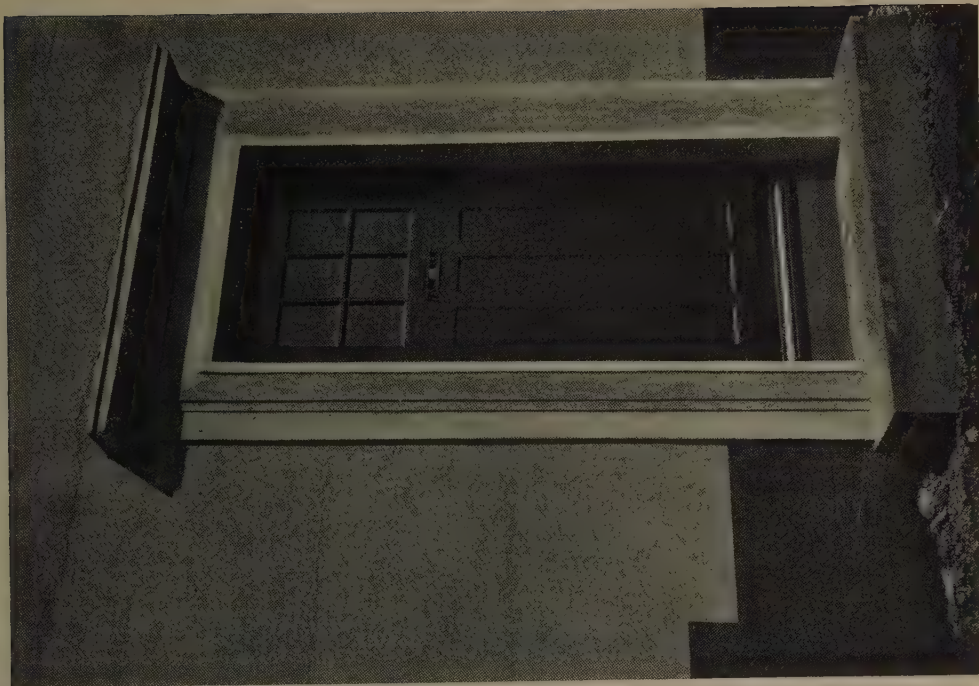
WELWYN GARDEN CITY,
ENGLAND.
SHREDDED WHEAT FACTORY.

GARTENSTADT WELWYN,
ENGLAND.
SCHROTMEHL FABRIK.



WELWYN GARDEN CITY, ENGLAND. DOMESTIC DOORWAYS

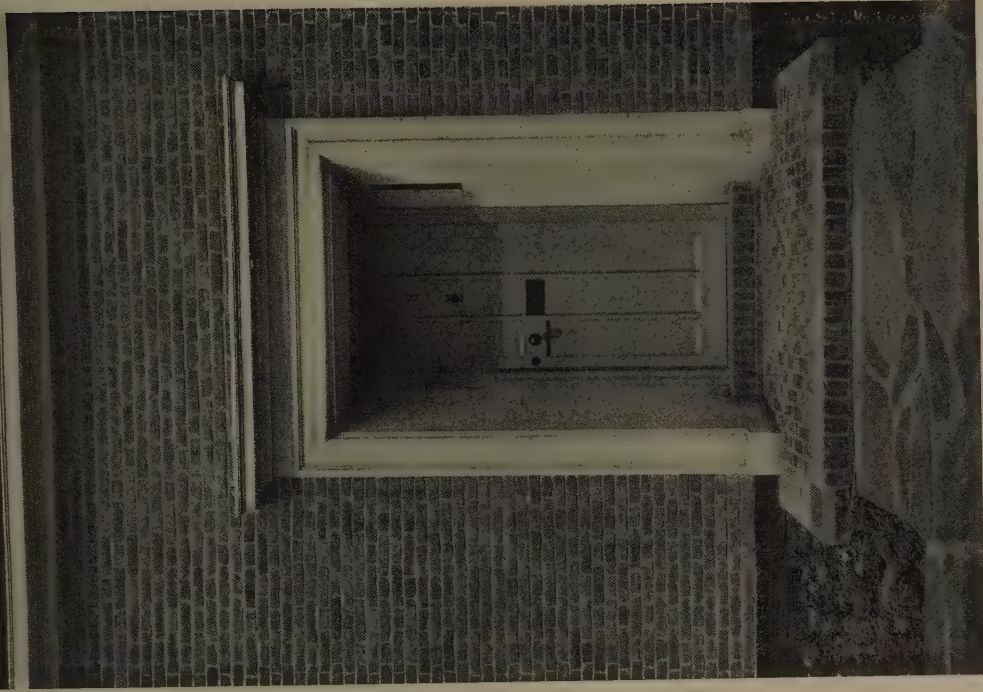
Arch.: L. de Soissons & A. W. Kenyon.



GARTENSTADT WELWYN, ENGLAND. HAUSTÜREN



WELWYN GARDEN CITY, ENGLAND. DOMESTIC DOORWAYS.
Arch.: *L. de Soissons & A. W. Kenyon.*



GÄRTENSTADT WELWYN, ENGLAND. HAUSTÜREN.
Arch.: *Hennell & James.*



PIEDMONT, CALIFORNIA, U.S.A. HIGH SCHOOL.

PIEDMONT, KALIFORNIEN, U.S.A. HÖHERE SCHULE,

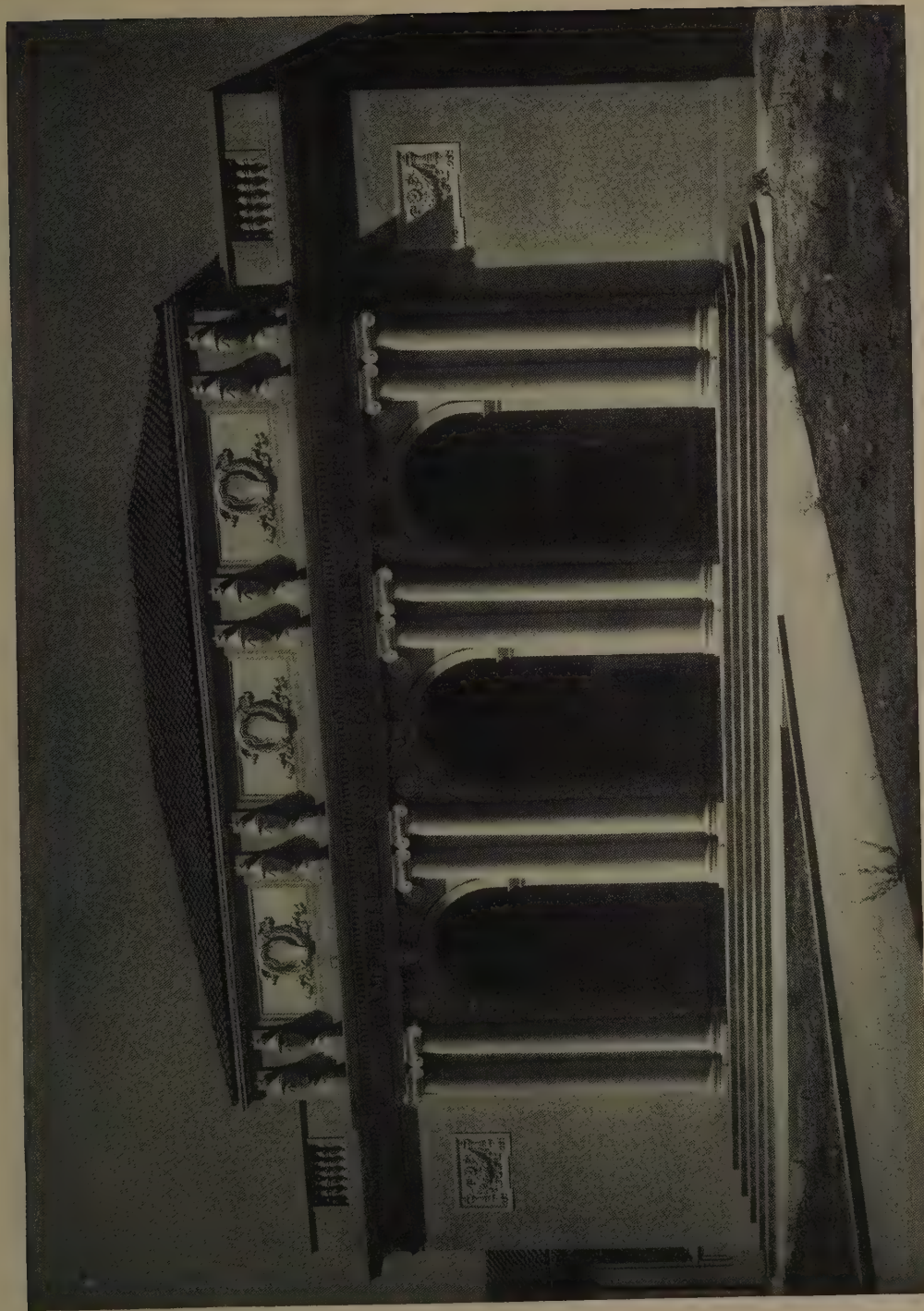
Arch.: W. H. Weeks.



PIEDMONT, CALIFORNIA, U.S.A. HIGH SCHOOL.

Arch.: W. H. Weeks.

PIEDMONT, KALIFORNIIEN, U.S.A. HÖHERE SCHULE.



CAMPBELL, CALIFORNIA, U.S.A. UNION GRAMMAR SCHOOL.

Arch.: W. H. Weeks.

CAMPBELL, KALIFORNIEN, U.S.A. UNIONSCHULE (ELEMENTAR SCHULE).



BURLUEGAME, CALIFORNIA, U.S.A. UNION HIGH SCHOOL.

Arch.: W. H. Weeks.
BURLUEGAME, KALIFORNIEN, U.S.A. UNIONSCHULE (HÖHERE SCHULE).



MOUNTAIN VIEW, CALIFORNIA, U.S.A.
HIGH SCHOOL.

Arch.: W. H. Weeks.

MOUNTAIN VIEW, KALIFORNIEN, U.S.A.
HÖHERE SCHULE.



PASADENA, CALIFORNIA, U.S.A.
COMMUNITY PLAYHOUSE.

Arch.: Elmer Grey.

LOS ANGELES, CALIFORNIA, U.S.A.
AUTO CLUB OF LOS ANGELES.

Arch.: Hunt & Burns.



PASADENA, KALIFORNIEN, U.S.A.
VOLKSHAUS.

LOS ANGELES, KALIFORNIEN, U.S.A.
AUTOMOBIL-CLUB VON LOS ANGELES.



SAN FRANCISCO, CALIFORNIA, U.S.A.
LEGION OF HONOUR.

Arch. : A. B. Applegart.

HEALDSBURY, CALIFORNIA, U.S.A.
HIGH SCHOOL.

Arch. : W. H. Weeks.



SAN FRANCISCO, KALIFORNIEN, U.S.A.
HAUS DER EHRENLEGION.

HEALDSBURY, KALIFORNIEN, U.S.A.
HÖHERE SCHULE.



HAMBURG, GERMANY. SCHOOL OF ARTS
AND CRAFTS, STAIRCASE.

Arch.: Professor Fritz Schumacher.

HAMBURG. TREPPENHAUS IN DER
KUNSTGEWERBESCHULE.



LOS ANGELES, CALIFORNIA, U.S.A.
GRAUMAN'S THEATRE.

LOS ANGELES, KALIFORNIE, U.S.A.
GRAUMAN'S THEATER.

Arch.: William Lee Woollett.



LOS ANGELES, CALIFORNIA, U.S.A.
GRAUMAN'S THEATRE.

LOS ANGELES, KALIFORNIE, U.S.A.
GRAUMAN'S THEATER.

Arch.: William Lee Woollett.



LOS ANGELES, CALIFORNIA, U.S.A.
GRAUMAN'S THEATRE.

Arch.: William Lee Woollett.

LOS ANGELES, CALIFORNIA, U.S.A.
GRAUMAN'S THEATRE.



LOS ANGELES, CALIFORNIA, U.S.A.
GRAUMAN'S THEATRE.

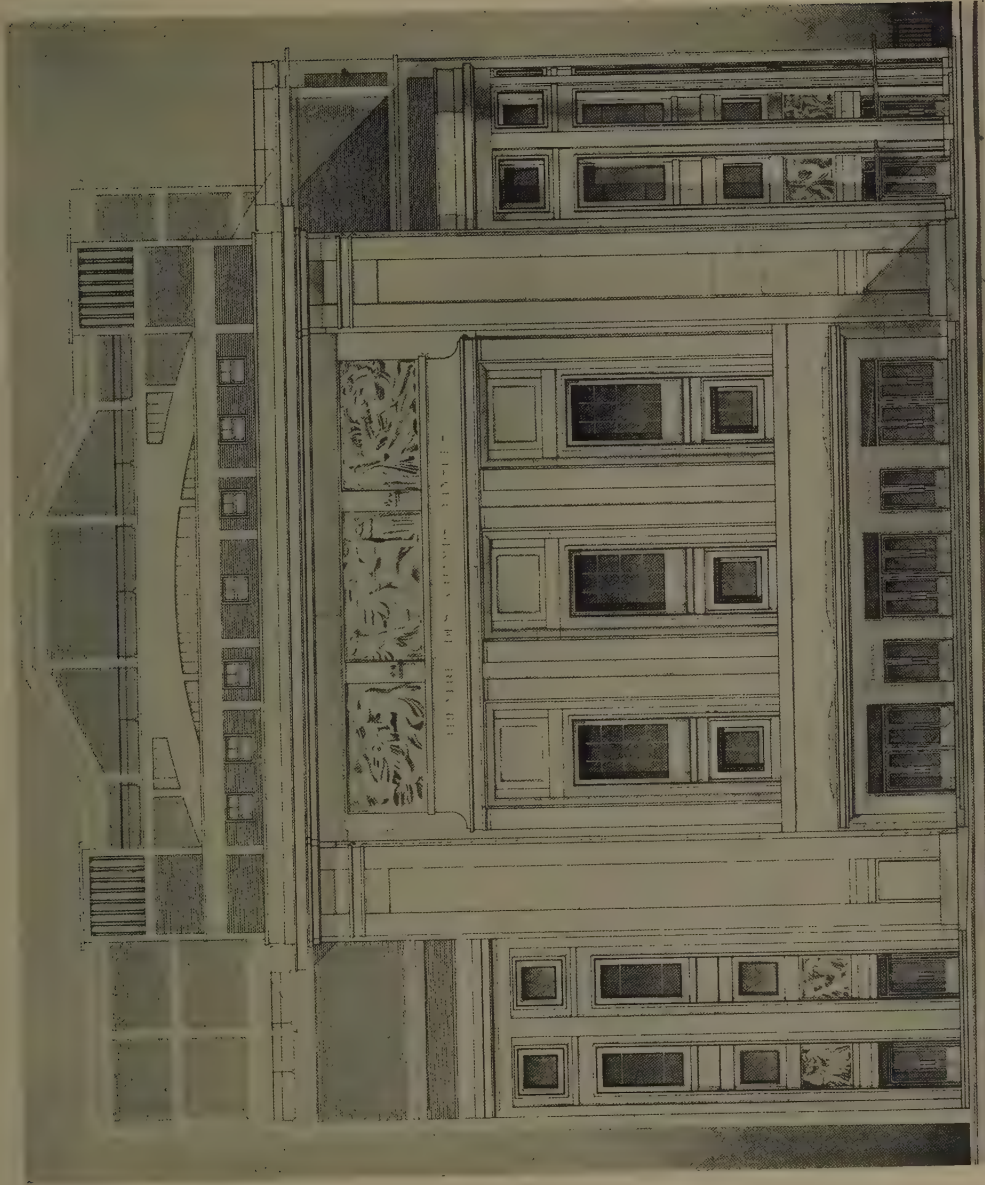
Arch.: William Lee Woollett.

LOS ANGELES, KALIFORNIEN, U.S.A.
GRAUMAN'S THEATER.



LOS ANGELES, CALIFORNIA, U.S.A. SHRINE, CIVIC AUDITORIUM.

LOS ANGELES, KALIFORNIEN, U.S.A. SHRINE VERAMMLUNGSSAAL.
Arch.: John C. Austin.



PARIS, FRANCE. THEATER CHAMPS ELYSEES.

Arch.: A. & G. Perret.

PARIS, FRANCE. CHAMPS ELYSEES THEATRE.



PARIS, FRANCE. CHAMPS ELYSEES THEATRE.

Arch.: A. & G. Perret.

PARIS, FRANKREICH. THEATER CHAMPS ELYSEES



STOCKHOLM, SWEDEN. SKURUBRON.

Engineer: A. Björkman.

STOCKHOLM, SCHWEDEN. BRÜCKE.



WELWYN GARDEN CITY, ENGLAND. BRIDGE.

Arch.: L. de Soissons & A. W. Kenyon.

GARTENSTADT WELWYN, ENGLAND. BRÜCKE.



WELWYN GARDEN CITY, ENGLAND. BRIDGE.

Arch.: L. de Soissons & A. W. Kenyon.



GARTENSTADT WELWYN, ENGLAND. BRÜCKE.



DACHAU, GERMANY. BRIDGE TO A FACTORY.

Arch.: Wayss & Freytag.

DACHAU, DEUTSCHLAND. BRÜCKE ZU EINER FABRIK.



SPOKANE, WASHINGTON, U.S.A. LATAH CREEK BRIDGE.

SPOKANE, WASHINGTON, U.S.A. BRÜCKE ÜBER DEN LATAH FLUSS.



SWEDEN. BRIDGE ON HALMSTAD-NOISSJÖ
RAILWAY.

VELANDA, SWEDEN. BRIDGE. (OLD IRON
BRIDGE EMBEDDED IN CONCRETE.)



SCHWEDEN. BRÜCKE DER HALMSTAD-NOISSJÖ
EISENBAHN.

VELANDA, SCHWEDEN. BRÜCKE. (ALTE EISENBRÜCKE
MIT BETON UMKLEIDET.)

Engineer: A. Björkman.



ERVALLA, SWEDEN. BRIDGE. (OLD IRON BRIDGE
EMBEDDED IN CONCRETE.)

ERVALLA, SCHWEDEN. BRÜCKE. (ALTE EISENBRÜCKE
MIT BETON UMKLEIDET.)

Engineer: A. Björkman.

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Aug 2 '44

Jan 14 '50

Aug 31 '53

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